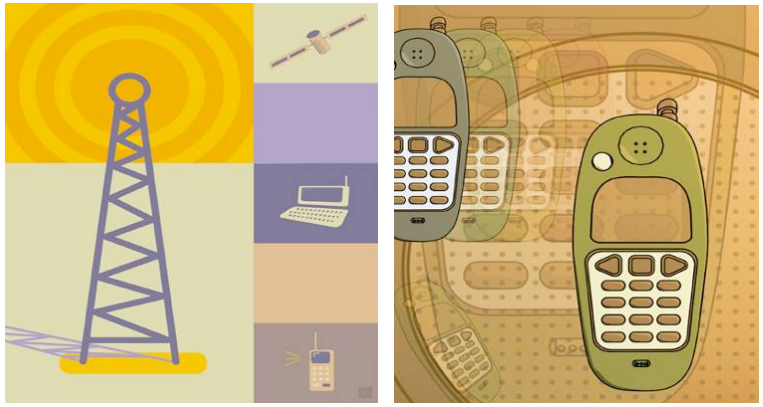
Business Models for Cognitive Radio – The Case of the Cognitive Pilot Channel



Pieter Ballon
Vânia Gonçalves
Makis Stamatelatos

Cognitive Radio – Technical Challenges and Commercial Implications Workshop

07.10.09 – Hamburg

About us

- IBBT-SMIT, Vrije Universiteit Brussel
  - ⇒ Specialised in Business modeling, User Studies & Policy Analysis related to ICT
  - ⇒ E2RII (Motorola) and E3 (Alcatel Lucent) Projects
  - ⇒ Joint IBBT-MIT Workshops on Cognitive Radio Standardization and Markets (Brussels, 11 May 2009 / 11 December 2009)
- National & Kapodistrian University of Athens
  - ⇒ Mobile/Wireless Communications, Advanced applications and services, Cognitive Radio systems and network management, Business modeling and accounting charging and billing schemes.
  - ⇒ E^2R-I, E^2R-II, LIAISON, E^3

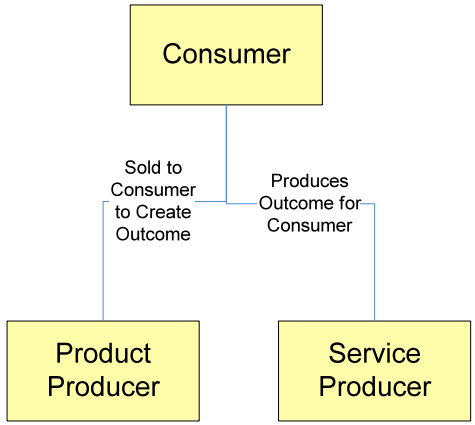
Outline

- Business Modelling Essentials
- The Business Model Construct – Operationalisation
- Archetypal CPC configurations
- Interview Approach
- Strategic Fit Assessment
- Validated CPC Business Models
- Conclusions

Business Modelling Essentials

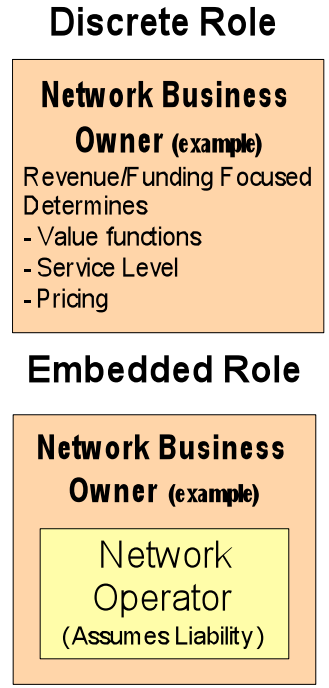
- **The Unified Business Model (UBM) is a business meta-model that aggregates viable business roles and their relations in a CR business eco-system**

- **Business Archetypes:** A value *producer* that provides consumer a value and gets paid for this by the *consumer,*



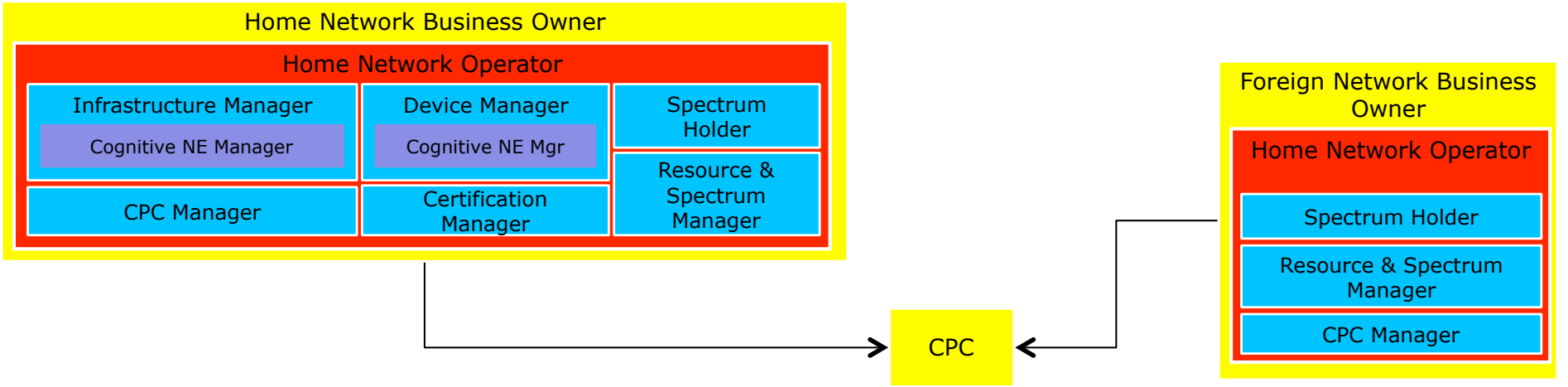
Business Modelling Essentials

- **Business Role:** abstract object representing an organization or person that performs a set of actions providing a set of discrete functions to another role.
  - ⇒ **Discrete Roles** sell their produced value to customers,
  - ⇒ **Embedded Roles** are integrated within discrete ones and get funded by their business owners.



- **The business ecosystem incorporates roles for**
  - ⇒ **Network service provision,**
  - ⇒ **Application service provision,**
  - ⇒ **Flexible spectrum and radio resource management ,**
  - ⇒ **Cognitive network management and the CPC related ones.**

The Unified Business Model: CPC "area"



- Home Network Business Owner (HNBO) provides network services to customers in its area and sets AAA rules as well as pricing, SLA, geography and spectrum strategy,
- Home Network Operator (HNO) provides customers and Network Business Owners wireless geographic coverage, based on a service level including volume and velocity and QoS.
- Device Manager is responsible for efficient management of devices native to the Home Network Operator domain,
- Infrastructure Manager undertakes corresponding responsibilities for overall network management (Routers, Base Stations etc),
- Cognitive NE Manager is responsible for tasks such as network performance analysis, reconfiguration management, context and policy management, traffic forecasting and decision making,
- Resource & Spectrum Manager addresses resource management aspects related to the different RATs administered by the Network Operator and cooperates with peer Managers for dynamic Spectrum Management purposes,
- Certification Manager ensures the authenticity of the downloaded software in case of reconfiguration actions,
- Spectrum Holder is responsible for spectrum usage rights,
- Foreign Network Business Owner (FBNO) provides network services to foreign users,
- Foreign Network Operator allows foreign users/devices to use its network based on FBNO's rules and guidelines,
- CPC (Cognitive Pilot Channel) is a discrete legal entity, an intermediary, potentially funded by a (F)NBOs consortium,
- CPC Manager is responsible for providing the content of the information sent over the CPC.

Business Modelling Context

- CPC as a central gatekeeper can have various implementations, with potentially very strong impact on industry architecture
- Which ones are viable?
- How to evaluate business viability *a priori* ?
  - ⇒ distribution of roles over actors cannot be taken as a given
  - ⇒ assumptions needed for business case cannot be made yet
- Architectural (re)design involved, also at industry level
  - ⇒ Mobile industry moving towards open platforms?
  - ⇒ Basic control and value stream choices
- In this case: business model analysis is appropriate

The Business Model Construct: Operationalisation

1. **Business model as architecture of *control* and *value* in network of firms**
2. **Business model archetypes around *gatekeeper role(s)***
3. **Business Model Configuration Matrix: crucial parameters and *trade-offs***
4. **Strategic fit within *contextual contingencies* and *power asymmetries***

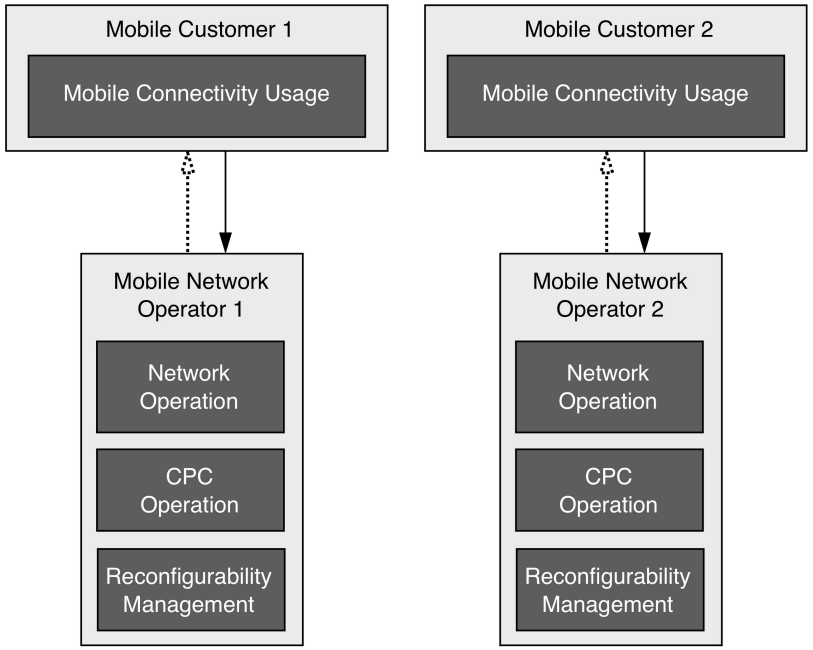
CONTROL PARAMETERS				VALUE PARAMETERS			
Value Network Parameters		**Functional Architecture Parameters**		**Financial Model Parameters**		**Value Configuration Parameters**	
Combination of Assets		Modularity		Cost (Sharing) Model		Positioning	
Concentrated	Distributed	Modular	Integrated	Concentrated	Distributed	Complement	Substitute
Vertical Integration		Distribution of Intelligence		Revenue Model		User Involvement	
Integrated	Disintegrated	Centralised	Distributed	Direct	Indirect	High	Low
Customer Ownership		Interoperability		Revenue Sharing Model		Intended Value	
Direct	Intermediated	Yes	No	Yes	No	Price/ Quality	Lock-in

CPC as gatekeeper role

- Solves lack of information in flexible spectrum context
- Adds value by facilitating seamless network selection and access
- Is bottleneck because it controls and coordinates information

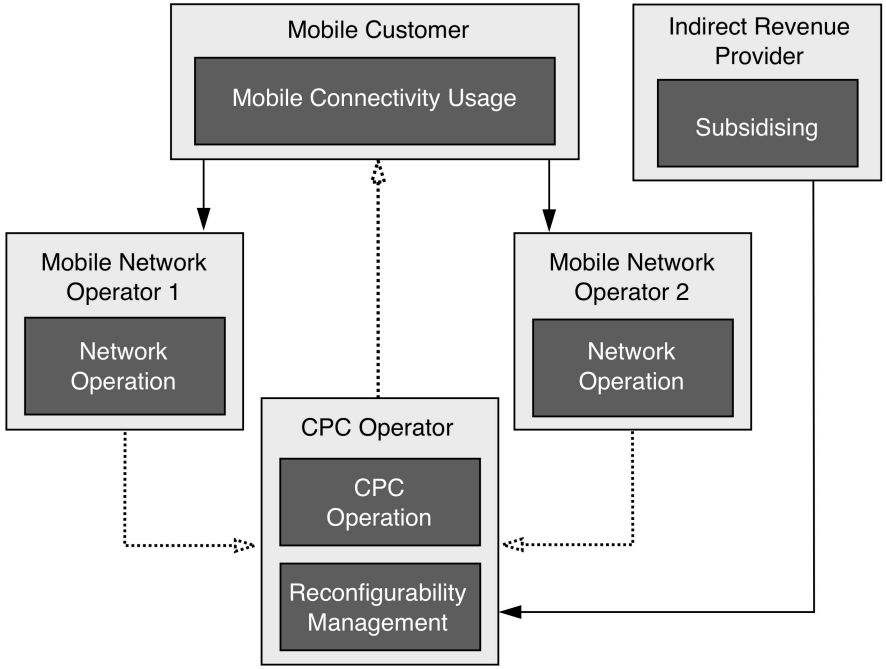
CPC archetypes (1/3)

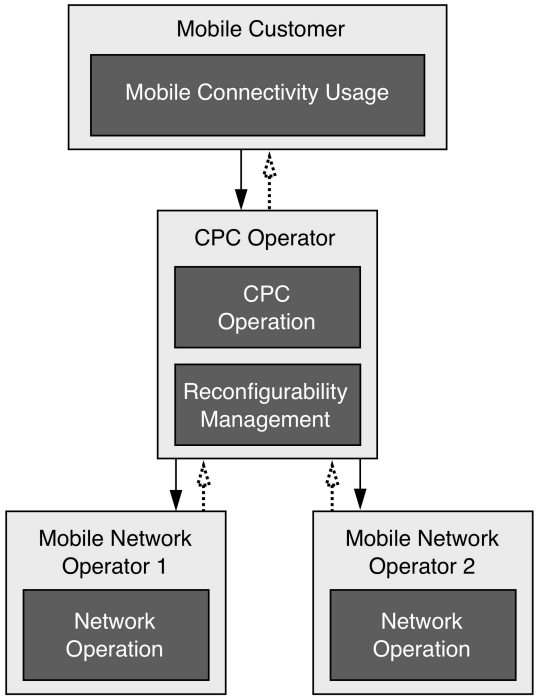
- ***Operator CPC*: operators deploy their own CPC. They control the parameters for the information that is offered by the CPC as well as the usage policies, and own the network over which the CPC information is transmitted**



CPC archetypes (2/3)

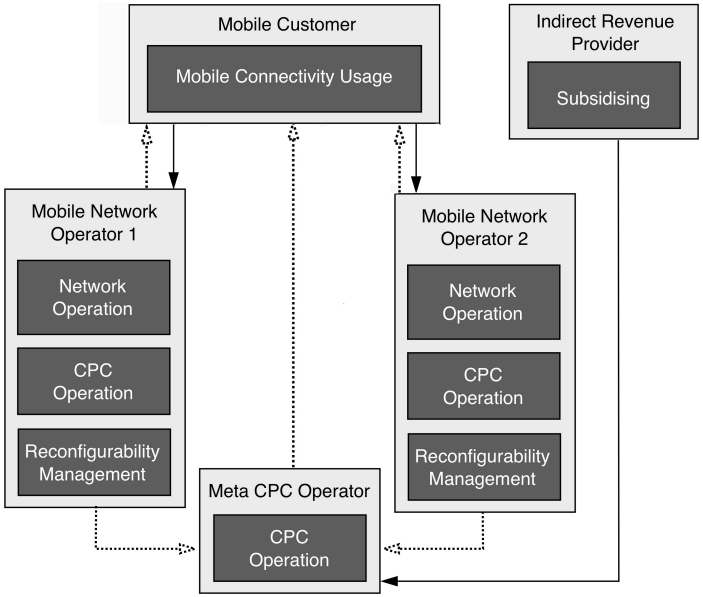
- ***Intermediary CPC*: one or more CPCs are operated by a non-operator entity. A public organisation such as the regulator or new business actors could take up the role of providing a CPC**

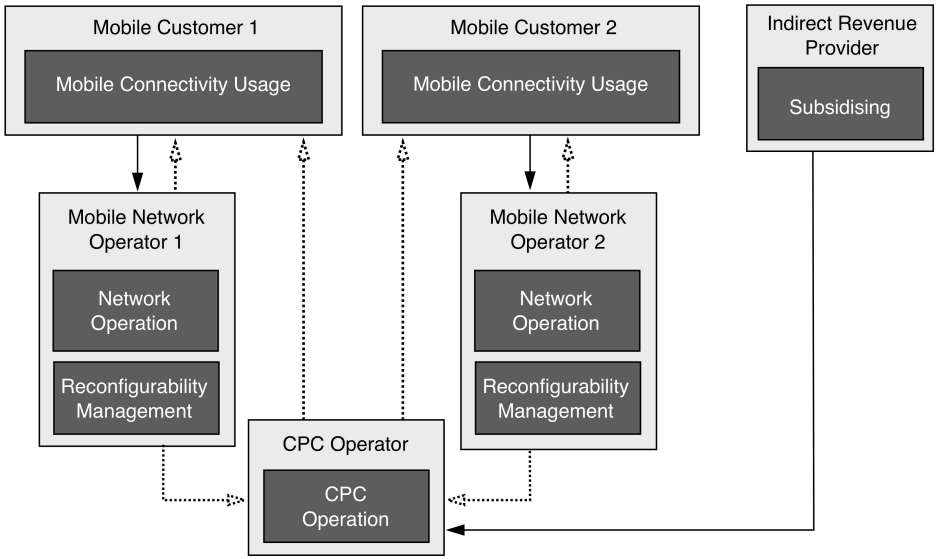




CPC archetypes (3/3)

- ***Hybrid CPC*: a general 'meta-CPC' is operated by either the regulator or an intermediary and refers to lower-level, individual CPCs deployed by the operators, within a hierarchical system. The meta-CPC can be non-exclusive or exclusive**





Interview Approach

- The interviews were in-depth and semi-structured, and were composed of a set of qualitative and open-ended questions
- They were conducted by telephone and took generally between 1 hour and 1 hour and 30 minutes
- Interviewees were sent a paper on the CPC concept and configurations identified earlier, as well as an indicative questionnaire, prior to the interview
- The business model configuration matrix was used to structure the analysis around the most relevant parameters and trade-offs

Interviewed experts

Title	Organisation	Country	Date of interview
Mobile Operators			
1. Senior Expert, New Network Technologies	Telefonica Movile	Spain	29 July 2007
2. Services Sciences Research Group Co-Leader	France Telecom	France	30 July 2007
3. Business Manager, Radio Network Planning	Telefonica Movile	Spain	31 July 2007
4. Technology Strategy Manager	Proximus	Belgium	15 Sept 2007
5. Head of Regulatory Affairs	Proximus	Belgium	15 Sept 2007
6. R&D Project Manager	Telecom Italia	Italy	24 April 2008
Telecom Vendors			
7. Global Marketing Manager	Motorola	UK	12 July 2007
8. Senior Specialist, Principal Engineer	Nokia Siemens Networks	Germany	26 Sept 2007
9. Product Manager	LG	France	26 Sept 2007
10. Standardisation Engineer	LG	France	26 Sept 2007
11. Manager, Research Department	Alcatel Lucent	Germany	19 Dec 2007
Regulatory and Competition Experts			
12. Senior Member	Tata Consulting Services	Europe and India	29 July 2007
13. Managing Director	T-Regs	Belgium	19 Oct 2007
14. Senior Consultant Ð Head of Mobile Broadband	IDATE	France	30 Oct 2007
15. Managing Director	SFC	UK	4 April 2008
16. Senior Fellow	Centre for European Policy Studies	Belgium	11 April 2008

Interview Questions (1/3)

A. Value network

1 Who should operate the CPC?
2 What are drivers and bottlenecks to operate the CPC?
3 Can a CPC function as an independent commercial company? Why (not)?
4 Will the owner of the CPC have a direct relationship with customers?
5 If the CPC is operator- or intermediary-based, can a user change from one CPC to another?

B. Functional Architecture

6 Should the CPC be integrated into the standard telecom infrastructure (e.g. as a logical channel within an existing RAT) or should it be separate from the existing infrastructure?
7 What kind of data can be sent from and to the CPC? Possibilities:
7.1 From operatorÕsside:
Available RATs, Capacity, Bandwidth, QoS parameters, Pricing
7.2 From customerÕsside:
Identification, Location, Desired service class, Device class/brand/OS etc., Desired QoS/bandwidth/price
8 Where should the decision-making on CPC-enabled service discovery lie?
8.1 User (active)
8.2 Device (policy)
8.3 CPC (brokerage function)
8.4 Operator (operator-originating policies, brokera ge function)
Should the bearer for different CPCs be standardized for all operators?

Interview Questions (2/3)

C. Financial Model

1 How do you estimate the site cost and operational cost of a CPC network? Given the difference between broadcast/on demand, different bearers, logical channel vs. separate CPC, spectrum sharing for different CPCs,É

2 How do you estimate the cost of CPC alternatives?

3 How do you estimate the capacity gain due to CPC-enabled Flexible Spectrum Management?

4 Can we expect consumers to pay for CPC-enabled services?

5 Can we expect operators to pay for being present onto an intermediary CPC?

6 Is there opportunity for indirect revenues via the CPC, either by government subsidies of via advertising?

7 If the CPC is operated by an intermediary, what kind of revenue sharing agreements could be envisaged?

8 When do financial transactions take place?

8.1 When a RAT is listed onto a CPC?

8.2 When a RAT gets priority listing on a CPC?

8.3 When a consumer makes use of a CPC to consult the parameters of a RAT?

8.4 When a consumer subscribes onto a CPC/brokerage function?

8.5 When a consumer makes a connection to one of the listed RATs?

a. When a consumer sends and receives data via one of the listed RATs?

Interview Questions (3/3)

D. Value Configuration

1 What kind of CPC-enabled, consumer-oriented services may be envisaged?
5.1 Choice of multiple, competing (substituting) or complementary RATs
5.2 Always best connected schemes
5.3 Always cheapest connected schemes
5.4 Other
2 What kind of CPC-enabled, operator-oriented services may be envisaged?
3 How would these products be positioned vis-ˆ-vis existing services?
4 To what extent will a CPC leave choice for users to select operators and RATs freely, and to what extent will this be regulated by
4.1 User defined policies within the terminal
4.2 CPC/broker strategies
4.3 Operator lock-in strategies
4.4 Operator lock-in strategies + operator defined policies
5 In the products offered to consumers, what strategy should be chosen?
5.1 Operational excellence
5.2 Product leadership
a. Customer intimacy

Strategic Fit assessment (1/12)

	Operators	Vendors	Regulatory experts
Combination of Assets	*Concentrated*	*Concentrated*	*Concentrated*
	Operators control crucial assets in terms of legacy networks, equipment and site ownership. Also, mobile operators control a range of confidential information on network deployment, local capacity, pricing and access network usage that is hard or impossible to obtain without their consent	Operators are well equipped to set up their own CPC at a fraction of the time and cost that it would take alternative providers. They have the leverage to influence policy makers as well as to acquire control over any competing independent CPCs	Any large-scale CPC implementation needs to leverage existing infrastructure as much as possible, thereby creating a major advantage for existing large mobile operators. Also, the Operator CPC model would create most value to large operators owning multiple RAT networks

Strategic Fit assessment (2/12)

Vertical Integration	*Integrated*	*Partially or Fu lly Integrated*	*Partially or Fully Integrated*
	The CPC should be an instrument that safeguards operator control over spectrum usage within a F SM context, rather than to further e rode this control. The Operator CPC i s preferred. Some 'closed platform' variants or a 'th in' Hybrid CPC, whil e not the preferred options, are seen a s potentially feasible	The Operator CPC is feasible, but in some cases the Hybrid CPC model is explici tly preferred over this. Some also consider that the Operato r CPC would allow complementary operators or that an operator consortium would establish a joint CPC	In first instance, an Operator CPC may be implemented. Afterwards, more collective models can be expected. The Hybrid model, with a consortium operating the meta-CPC, is advocated b y most competition experts

Strategic Fit assessment (3/12)

Customer Ownership	*Direct*	*Direct*	*Direct*
	Users will not be able to scan different operator CPCs, nor to switch between operators in a dynamic manner	Most end-users do not value a brokerage function in order to actively switch between operators. Some experts envisage that end-user terminals will be able to 'see' different CPCs when connecting to a meta-CPC	Operators should be free to implement their own business models. No agreement as to whether user terminals would be able to 'see' different CPCs when connecting to a meta-CPC

Strategic Fit assessment (4/12)

Modularity	*Modular, Semi-Modular or Integrated*	*Semi-Modular*	*Semi-Modular*
	Difference of opinion or indecision as to whether the CP C should be an 'out - band' channel, independent of legacy systems and RATs, or an 'in - band' logical channel within existing systems and RATs	The optimal trade-off may be either an in-band solution that incorporates some form of modularity, e.g. by designing the CP C as an application server that could be separated from the network management domain, or as a Hybrid CPC, with a general out-band channel being combined with an operator-specific channel that contains most of the CPC functionality	What is advocated is an in-band CPC tha t makes use of operators' existing network infrastructure, possibly (and in most cases, preferably) combined with a meta-CPC that makes use of existing or dedicated infrastructure of the meta-CPC consortium members

Strategic Fit assessment (5/12)

Distribution of Intelligence	*Mostly Centralised*	*Mostly Centralised or Partly Distributed*	*Partly Distributed*
	The Operator is responsible for optimising network behaviour. Some consider that there might be generic policies set in advance by the users for selecting particular RATs within the operator's domain	The responsibility for optimising QoS and cost should lie with the operators. Still, the end-user may be triggered to make certain choices and may be presented with price information in the form of advertisements	Most intelligence is located at the operator's side. The data on the meta-CPC side should be restricted. There may be policy-based network selection, set by end-users

Strategic Fit assessment (6/12)

Interoperability	*Standardised*	*Some elements standardised*	*Some elements standardised*
	The CPC should be standardised either as stand-alone solution or inside a cellular technology. A Hybrid CPC could accelerate introduction, by only standardising the meta-CPC	In case of an out-band (meta-)CPC, the bearer network should be standardised, at least on a European level. In case of an in-band CPC, only the detection procedure should be standardised	Non-standardisation of the CPC technology may cause the reach and comprehensiveness of the CPC to be restrained. Yet standardisation risks to diminish any advantages of inter-technology competition. A Hybrid CPC model might strike the best balance between both considerations

Strategic Fit assessment (7/12)

	Operators	Vendors	Reg. experts
Cost (sharing) model	*Mostly Concentrated*	*Mostly Concentrated*	*Partly Distributed, Partly Concentrated*
	Cost of Operator CPC is relatively light for established operators, high for others	Cost of a CPC is relatively low if existing infrastructure is used and/or if an application server logic is employed	Costs are partly distributed as far as a consortium model is advocated, and as partly concentrated regarding the individual operator investments in an Operator CPC

Strategic Fit assessment (8/12)

Revenue model	*Indirect*	*Indirect*	*Indirect*
	The CPC is primarily a way to increase efficiency and thus to cut costs and increase profitability. In addition, new connectivity bundles could be proposed, within a flat fee revenue model logic	The CPC can function as an advertising and marketing channel. Also, it may allow operators to avoid a part of their network costs, and enable them to more optimally distribute their end-users over the various radio access networks	Indirect revenues are generated through cost reduction, better quality of service, the facilitation of additional services, and an expansion of opportunities to use existing services. Versioning of flat fee packages is also envisaged

Strategic Fit assessment (9/12)

Revenue sharing model	*Yes, no specif ic role f or CPC*	*Yes, with limited role f or CPC*	*Yes, with role f or CPC*
	National roaming agreements would mirror current international roaming agreements	Revenue sharing may take place as a result of roaming and /or as a result of usin g other operators' CPC infrastructure	Revenue sharing may take place as a result of inter - operator roaming agreements and of sharing CPC capacity

Strategic Fit assessment (10/12)

	Operators	Vendors	Reg. experts
Positioning	*Complement*	*Complement*	*Complement*
	The CPC is mainly an enabler to manage and control heterogeneity, and optimise network efficiency. Market positioning would not change at all or only slightly by offering more user choice and favouring large operators	The CPC may be mainly invisible to end-users, in terms of both functionality and positioning of operators. Alternatively, an 'always best connected guarantee' could constitute an additional selling point for current operators. The CPC could also be visible to users in the form of an information or marketing channel	The CPC, rather than to lead to strongly disruptive changes, will enable a series of opportunities for differentiating the market positioning of operators, through versioning, facilitating new services and so on

Strategic Fit assessment (11/12)

User involvement	*Limited or non-existent*	*Limited or non-existent*	*Limited*
	The CPC functionalities should be as Ô invisibleÕ as possible, a.o. because of the shift towards flat rates for connectivity, and the negative influence on user value of customers having to make frequent network connectivity choices. There could possibly be some user pre-sets	Most or all of the responsibility for optimising network parameters should lie with the operators. Possibly, a restricted number of relevant instances could be filtered out for which the user is triggered to make an active choice	Some doubts as to whether end-users will have the possibility to 'see' different CPC. Even in the case that 'active' switching between RATs and/or providers is allowed, this should take place as a result of policies of which some are set in advance by the operator and others by the end-users

Strategic Fit assessment (12/12)

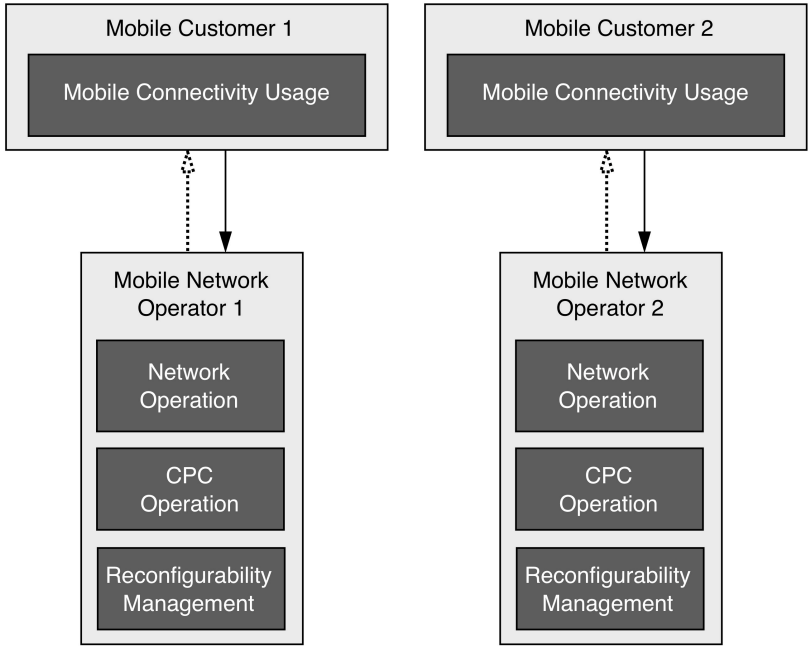
Intended value	*Mixed*	*Mixed*	*Mixed*
	Spectrum efficiency enhancing tools such a s the CPC should a llow optimisation of the price/quality ratio, but these advantages may be mostly absorbed by operators. The limited user choice, th e provision of flat fee connectivity packages and the single operato r control over the information provided by the CPC promote a customer intimacy o r 'lock-in' strategy	Through the optimisation of radio access network selection, end-users could be offered either the guarantee of bein g 'best connected within certain cost constraints', or of enjoying very cheap free connectivity. In addition, the CPC is likely to b e employed to keep end-users within a single operator's domain	Customer intimacy may dominate in the short term, while optimisation of the price/quality ratio may dominate in the longer term. Various opportunities for inter-operator differentiation are foreseen, because of divergent CPC implementations and opportunities to offer a range of additiona l services

Discarded CPC business models

- ***Intermediary commercial CPC:*** **introduces single point of failure, does not have necessary control over data, no strategic fit between stakeholders, control of customers not aligned with control of gatekeeping roles, continuous customer choice in terms of mobile access decreases instead of increases customer value**
- ***Intermediary regulatory CPC:*** **introduces single point of failure, no strategic fit with main stakeholders, continuous customer choice in terms of mobile access decreases instead of increases customer value**
- ***Hybrid regulatory CPC:*** **regulatory body is most likely to outsource meta-CPC functionality (cfr. Number portability databases etc.)**
- ***Hybrid commercial CPC:*** **no commercial value proposition**

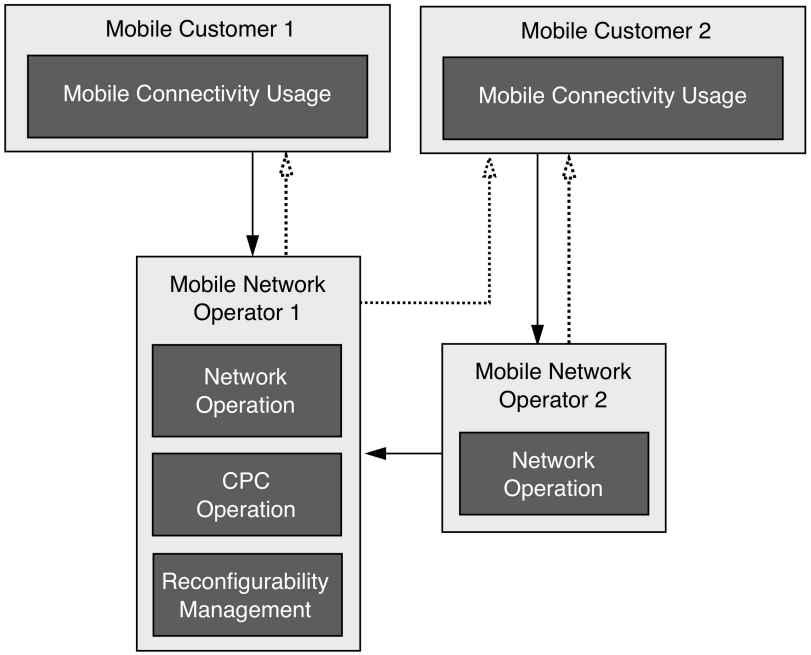
Validated CPC business models (1/3)

- *Operator CPC*: all operators have their own CPC. Operators control most of the value network and technical and customer-data on the CPC
- Users switch (passively or actively) between their home operator's available networks but continuously remain within the same business domain. Any technical platform activity in case of spectrum trading is transparent
- Pre-established revenue sharing models set the rules for clearing between the network operators (national roaming)



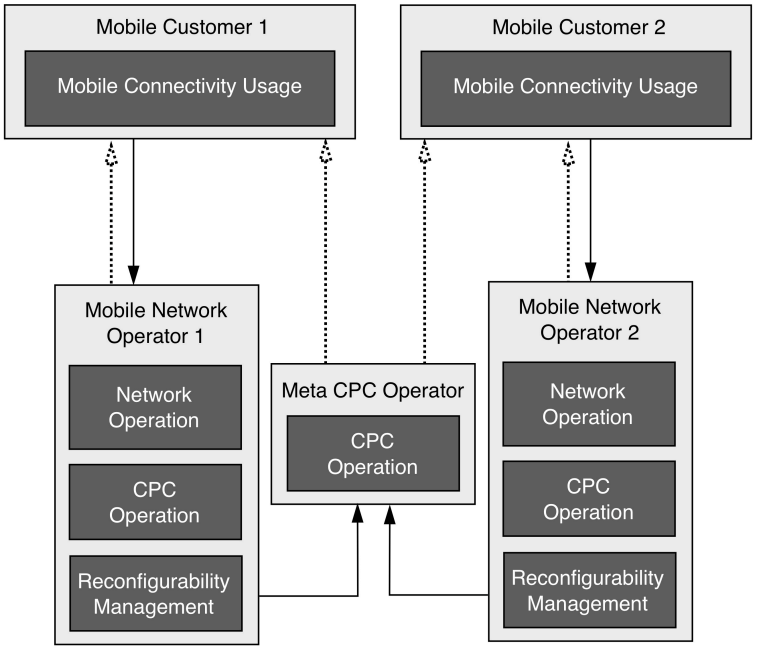
Validated CPC business models (2/3)

- ***Extended Operator CPC*: CPC functionality is opened up to other connectivity providers that do not possess a CPC infrastructure. This is a platform in a business sense because users can access different business domains**
- **However, Operator CPC platform not available to every stakeholder. Mainly complementary operators: in terms of network reach (i.e. smaller operators with niche technology or with network deployment in a limited area), or in terms of customer reach (i.e. MVNOs with attractive branding)**



Validated CPC business models (3/3)

- ***Hybrid Consortium CPC:*** **Information provision for large ones and small operators, while operators retain control over own pilot channel and over own connectivity offering. From the 3 strategically feasible models, this one alleviates most the regulatory experts' concerns**
- **Only one CPC channel needs to be known *a priori* by the device.**



Conclusions (1/4)

- UBM integrates the 2 viable CPC deployment scenarios into the reference model
- More detailed semantics may be provided after the stabilisation of the most viable scenarios and in parallel to the CPC technical work
- The need for a CPC-type functionality as well as the likelihood of any major business model reconfiguration depend on the (uncertain) persistence and intensification of both heterogeneity in networks and flexible spectrum management

Conclusions (2/4)

- Even under such circumstances, no strongly disruptive outcome vis-à-vis the current business model configuration
  - ⇒ Interpretation of the introduction of AWTs and even of FSM as not necessarily negative for current mobile operators' businesses
  - ⇒ Estimation that the assets to compete in the mobile access provision domain, and more specifically to offer the CPC's gatekeeping functionalities, are firmly controlled by established mobile operators
  - ⇒ Expectation that moving (most of) the CPC functionalities away from the operators would diminish, rather than increase, customer value, because it would potentially lead to information overload and to unpredictable tariffs for connectivity

Conclusions (3/4)

- **Towards platform rather than integrated model?**
  - ⇒ **Platformisation depens on increasing trend to RAT heterogeneity and flexibility of spectrum**
  - ⇒ **Validated business models include two platform models as well as an integrated, non-platform model. The first platform model concerns an Extended Operator CPC model in which the operator uses its CPC as a platform for (mostly complementary) smaller operators and MVNOs. The second one refers to a Hybrid Consortium CPC model in which a meta-CPC is set up by a consortium of operators, and functions as a platform providing generic information on the location of individual operators' CPCs.**
  - ⇒ **Whether platformisation will in fact take place in such a context, depends a.o. on the cost structure as well as the cost saving potential of particular CPC implementations, and on the regulatory insistence on a joint solution**
  - ⇒ **any further reconfiguration and platformisation beyond these validated models depends on regulatory intervention that would go significantly further than the current consensus**

Conclusions (4/4)

- **Strategic Fit around the value configuration related to CPC and cognitive radio**
  - ⇒ **Customer intimacy and Operational excellence, Not diversity of offerings is stressed. A CPC will firstly ensure efficiency and seamlessness; and secondly (in case of the platform models) will safeguard the existence of niche operators**

Questions?

- **Contacts:**

pieter.ballon@vub.ac.be
vania.goncalves@vub.ac.be
makiss@di.uoa.gr

This work was performed in project E3 which has received research funding from the Community's Seventh Framework program. This paper reflects only the authors' views and the Community is not liable for any use that may be made of the information contained therein. The contributions of colleagues from E3 consortium are hereby acknowledged.