Holistic View on 5G

Coordinators 5G Lab Germany:

Gerhard P. Fettweis Vodafone Chair Professor

Frank Fitzek Communication Networks Chair

Via Della Conciliazione

2005/4/4

Source: http://www.spiegel.de/panorama/bild-889031-473266.html

2013/3/12

Source: http://www.spiegel.de/panorama/bild-889031-473242.html

Quelle: japantimes.co.jp/news/2014/09/30/asia-pacific/hong-kong-democracy-protesters-set-deadline-for-demands/

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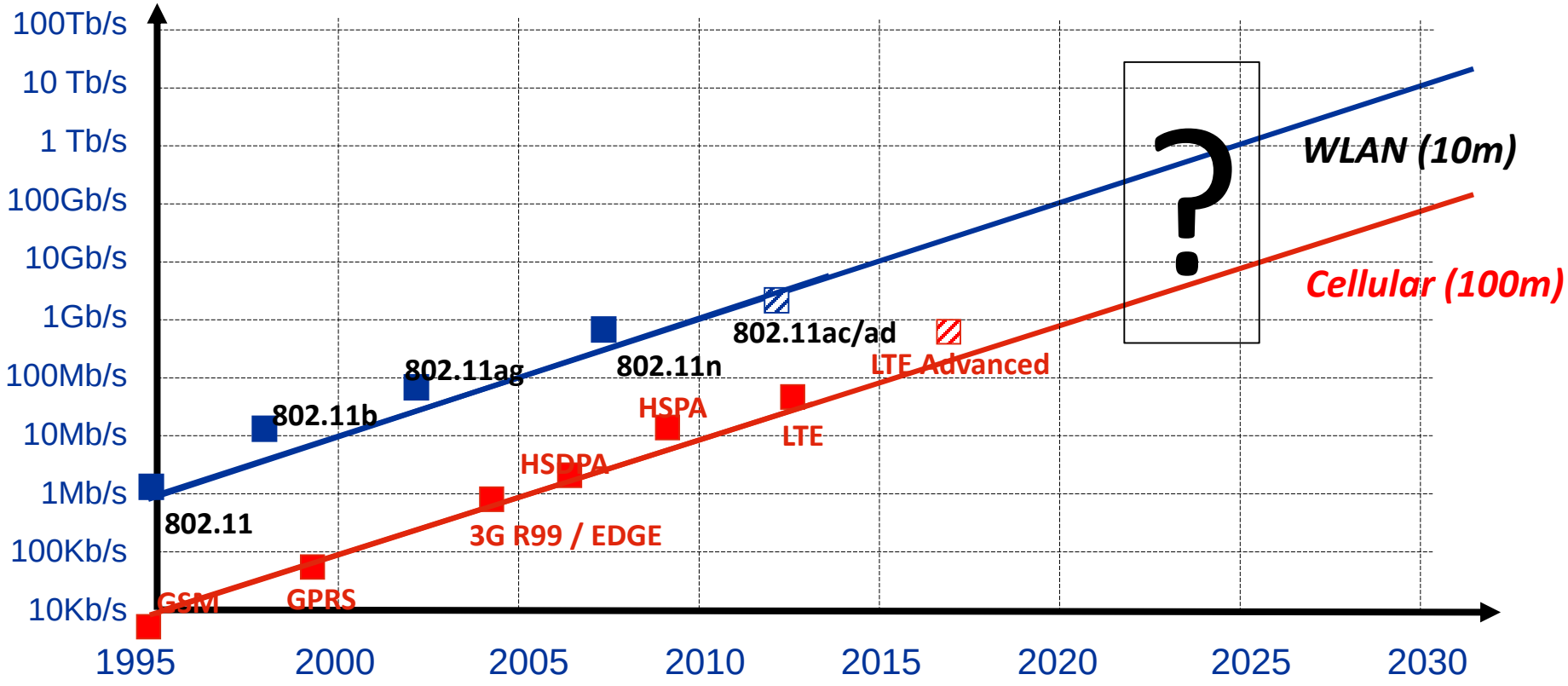
Wireless >2020 Outlook



The Tactile Internet

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Moving from 25ms RTT → 1ms tomorrow

http://ostsee-spezial.de/?p=148

Gaming…

http://popular-pics.com/Cool_World_Record_LAN_Event_Computer_Pictures__5

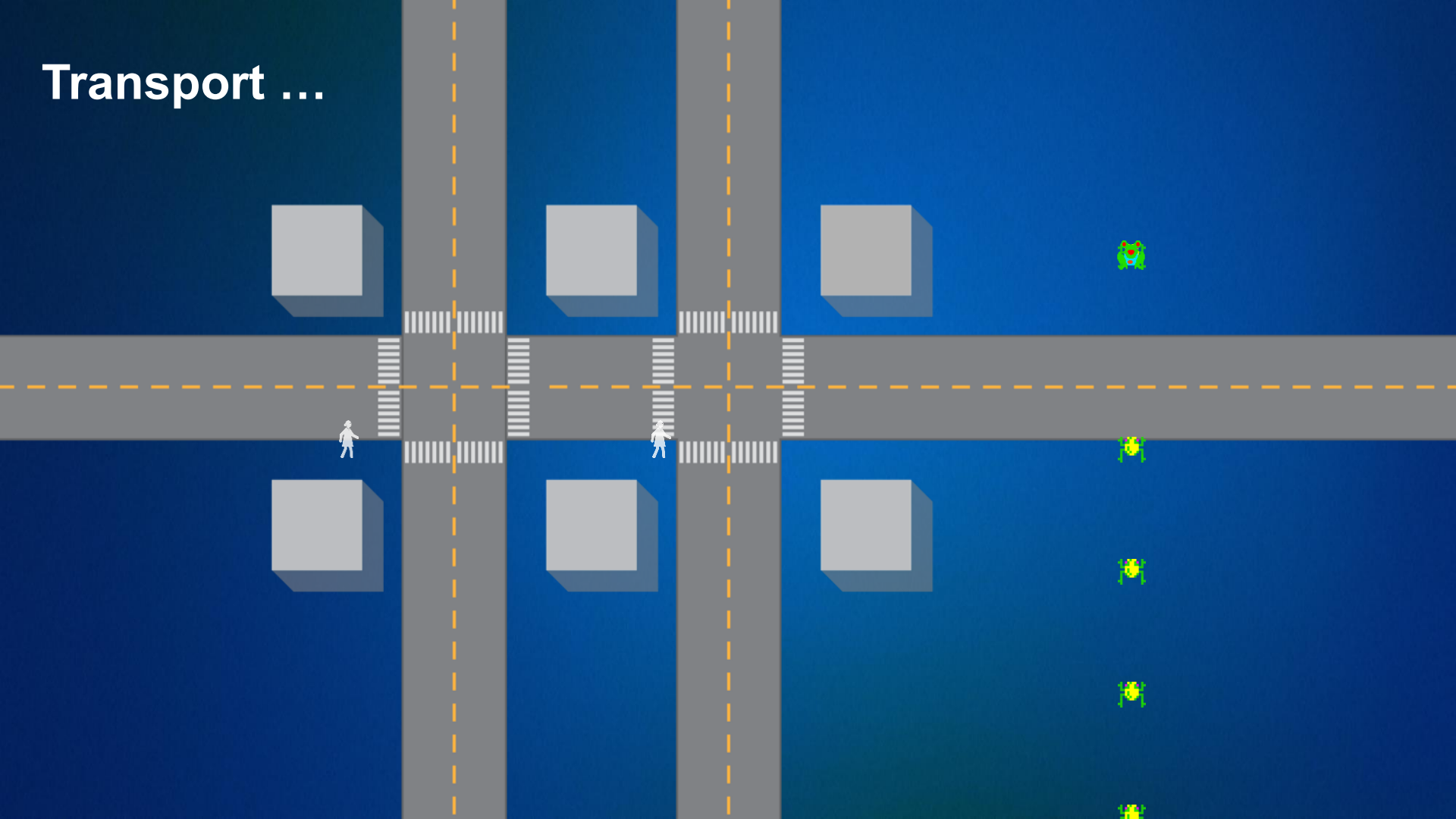
http://gametaffy.com/imho-the-lan-party/

The Manufacturing Revolution Ahead

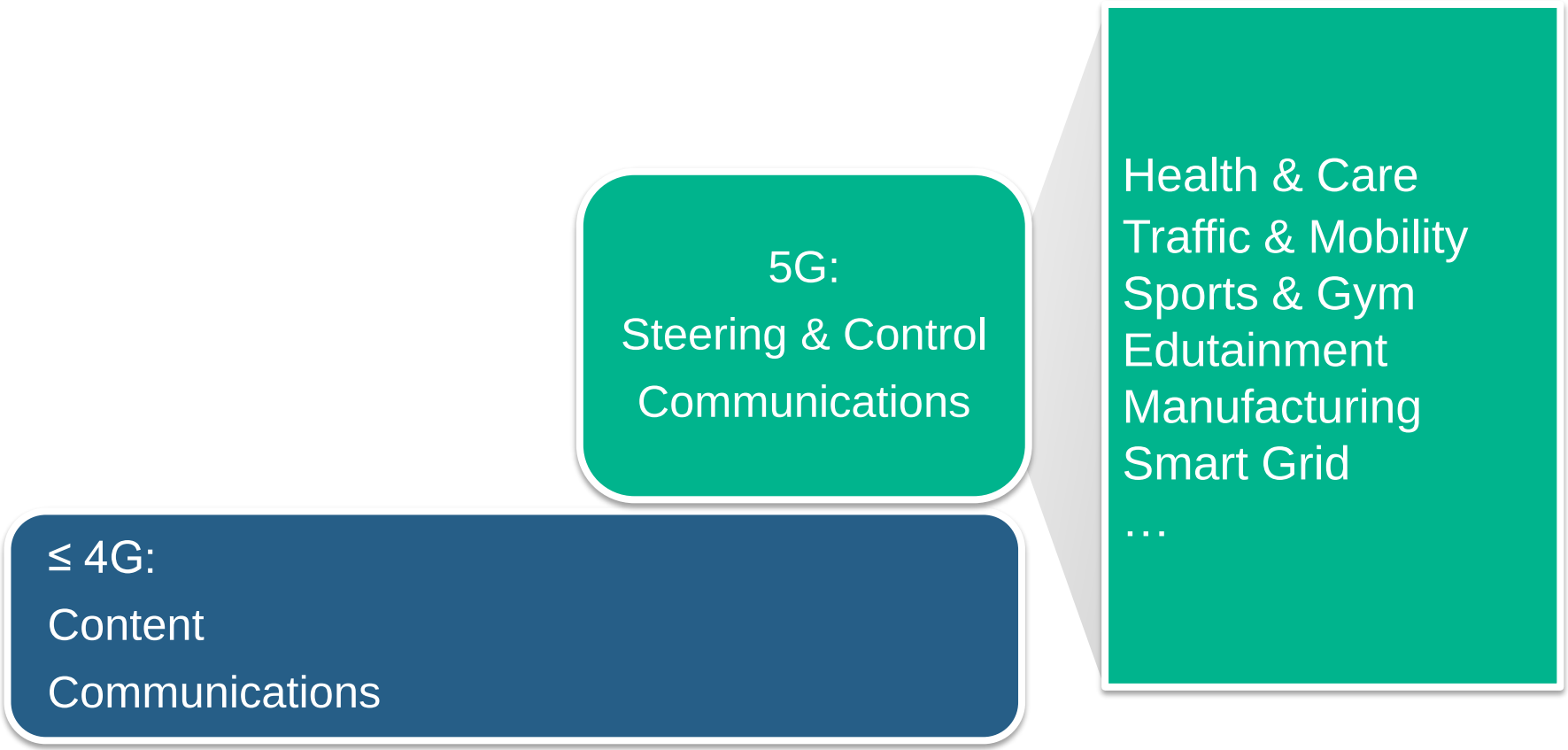
http://jerryrushing.net/wp-content/uploads/2012/04/robotic_assembly_line1.jpg

http://www.witchdoctor.co.nz/wp-content/uploads/2013/01/robot-fabrication-station.jpg

Transport …



Revolution Ahead: The Tactile Internet



5G – “Massive” Requirements

State of the art

- Massive throughput
- Massive low latency
- Massive sensing
- Massive resilience
- Massive safety and security
- Massive fractal heterogenity

5G

The Tactile Internet

> 10Gbit/s per user

< 1ms RTT

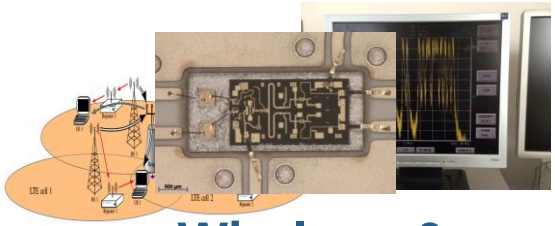
> 10k sensors per cell

$< 10^{-8}$ outage

$< 10^{-12}$ security

10x10 heterogeneity

5G Research on four Tracks



Wireless & Networking

Tactile Internet applications

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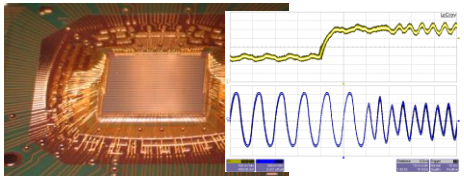
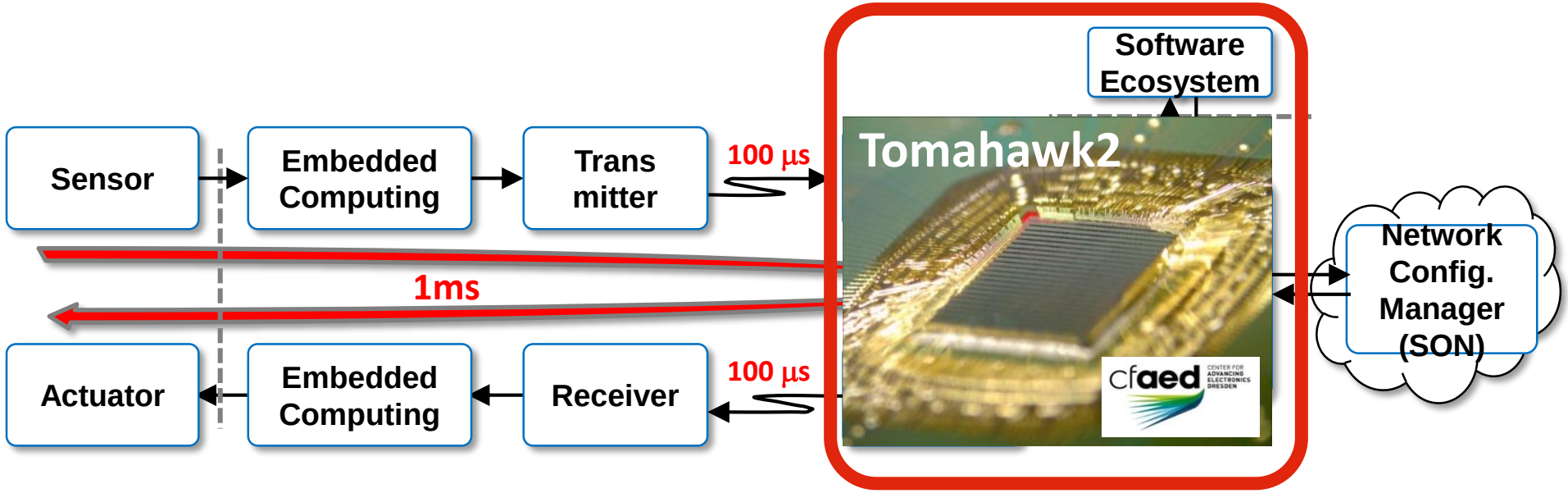


Silicon systems

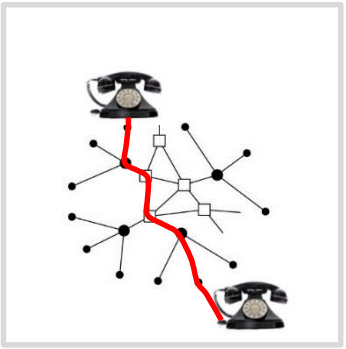
Mobile edge cloud

1ms Impact


Sensor
Embedded Computing
Trans mitter
100 µs
Software Ecosystem
Tomahawk2
Network Config. Manager (SON)
1ms
Actuator
Embedded Computing
Receiver
100 µs
Latency Goals:
Σ = 0.2 ms
Air Interface
Σ = 0.3 ms
Terminal
Σ = 0.5 ms
Base Station & Compute

Communication Networks

***Circuit* Switched Networks**



Voice

Communication Networks

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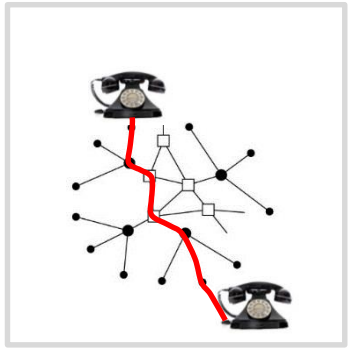

Voice

Revolution

***Packet* Switched Networks**

Voice

Data

Communication Networks

5G LAB GERMANY

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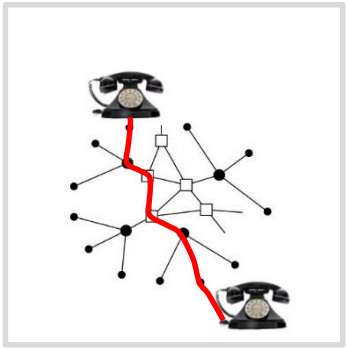

Voice

Revolution

***Packet* Switched Networks**

Voice

Data

Technical Challenges

Massive throughput

Massive reduction in delay

Massive resilience

Massive safety & security

Massive heterogeneity

Massive sensing

Massive energy saving

Use Cases

Internet of Things (IoT)

Smart Grids

Remote Cars

eHealth

Flying Internet

Robotics

Communication Networks

5G LAB GERMANY

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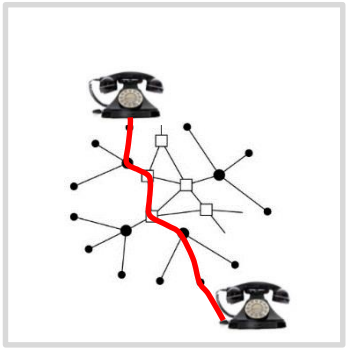

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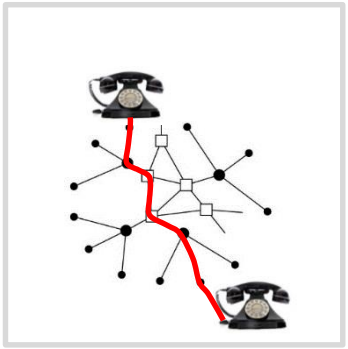

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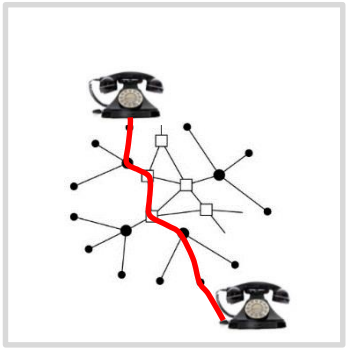

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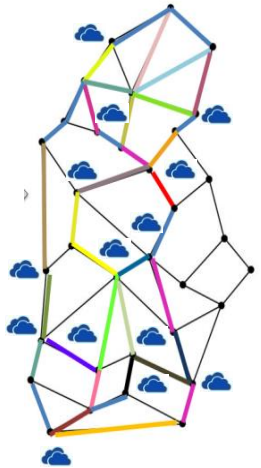

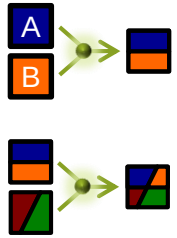

Voice

Data

Control

Communication Networks

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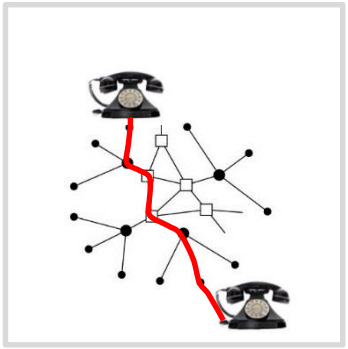
***Circuit* Switched Networks**



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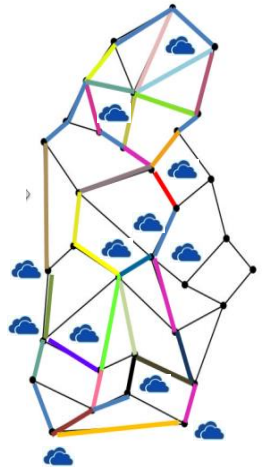

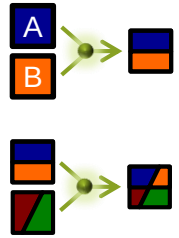

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5G LAB GERMANY

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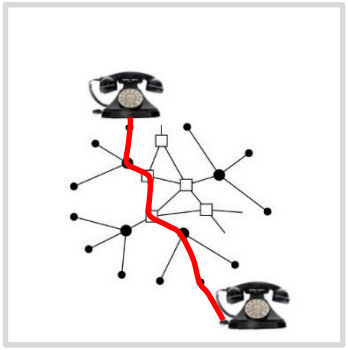

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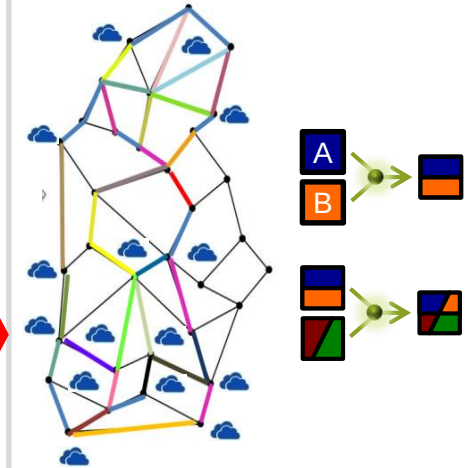
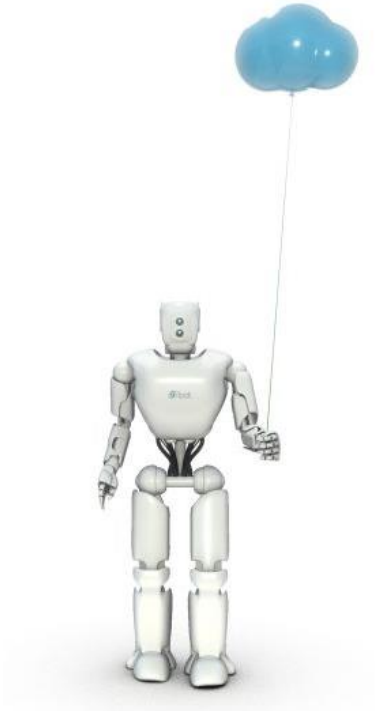


Voice

Data

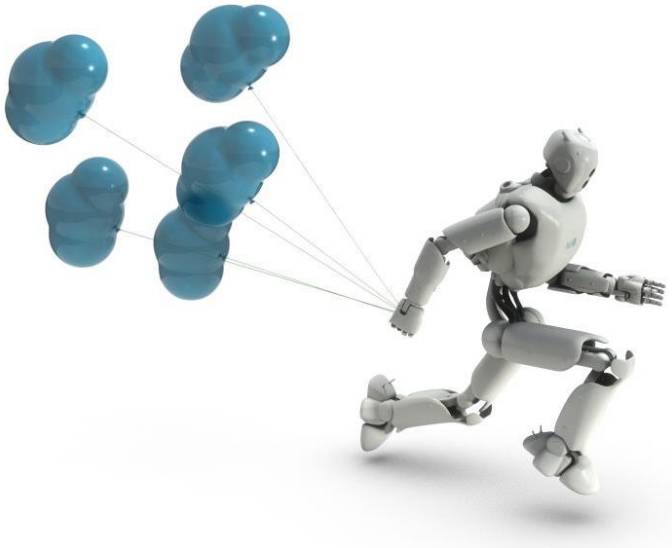
Control

Cloud Evolution



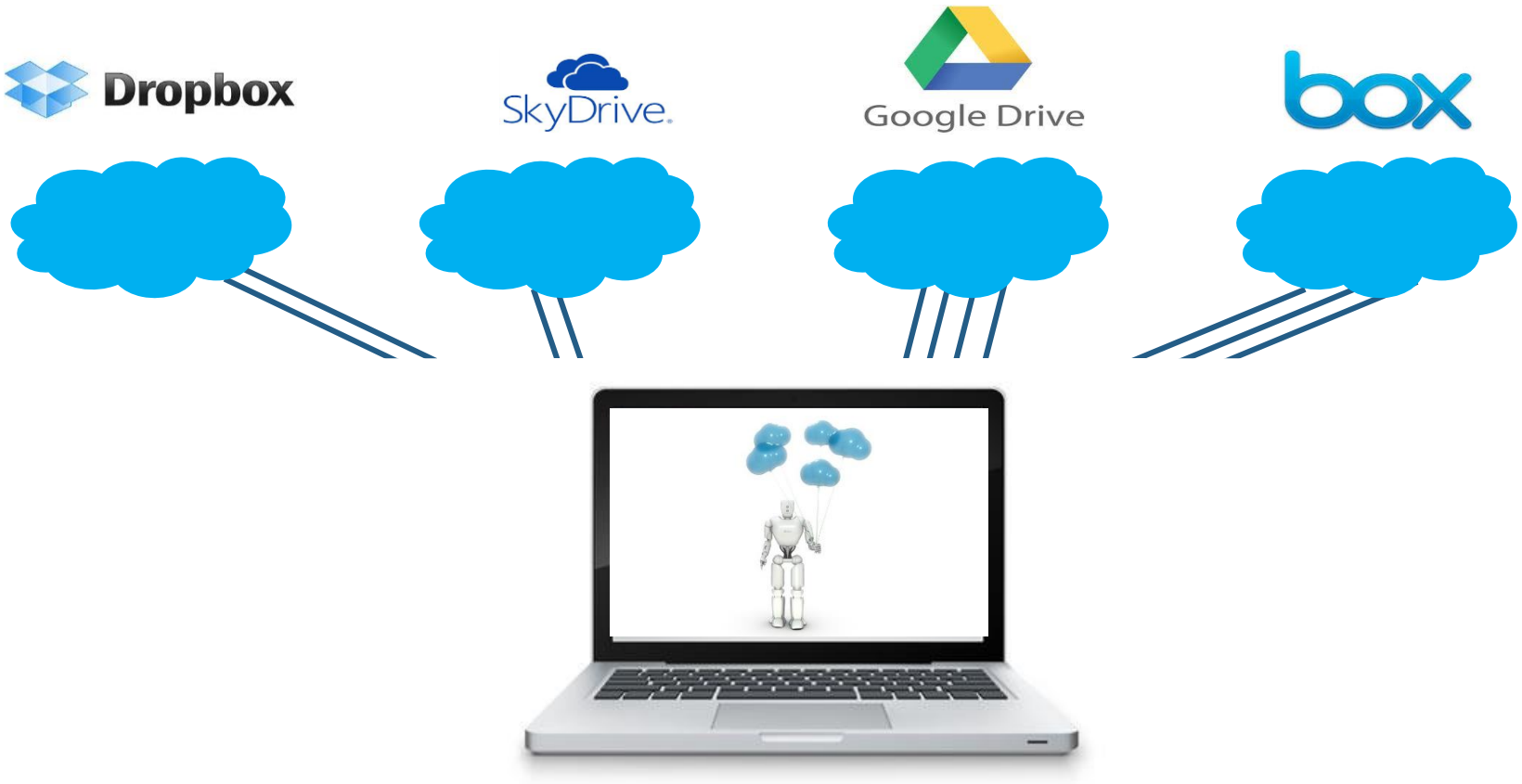
Single/Static

Distributed/Static



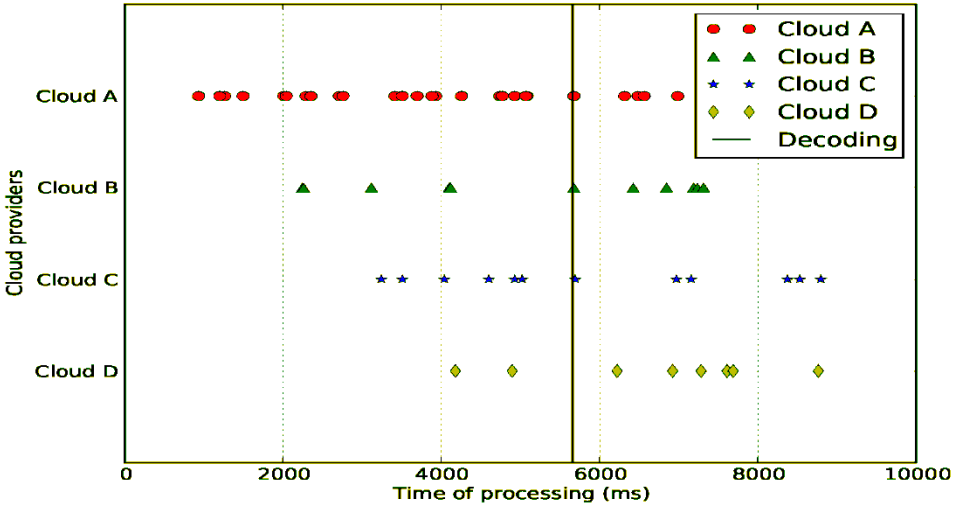
Distributed/Agile

Example: Distributed Cloud

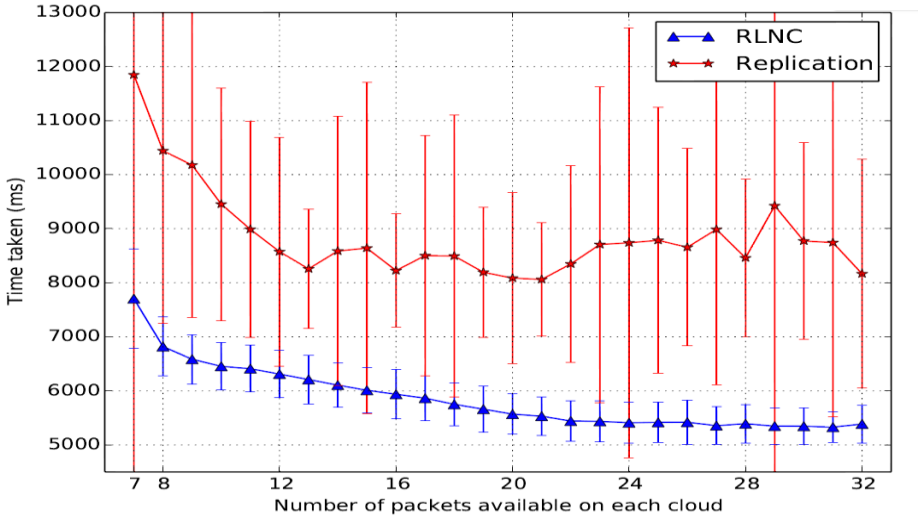


Example: Distributed Cloud

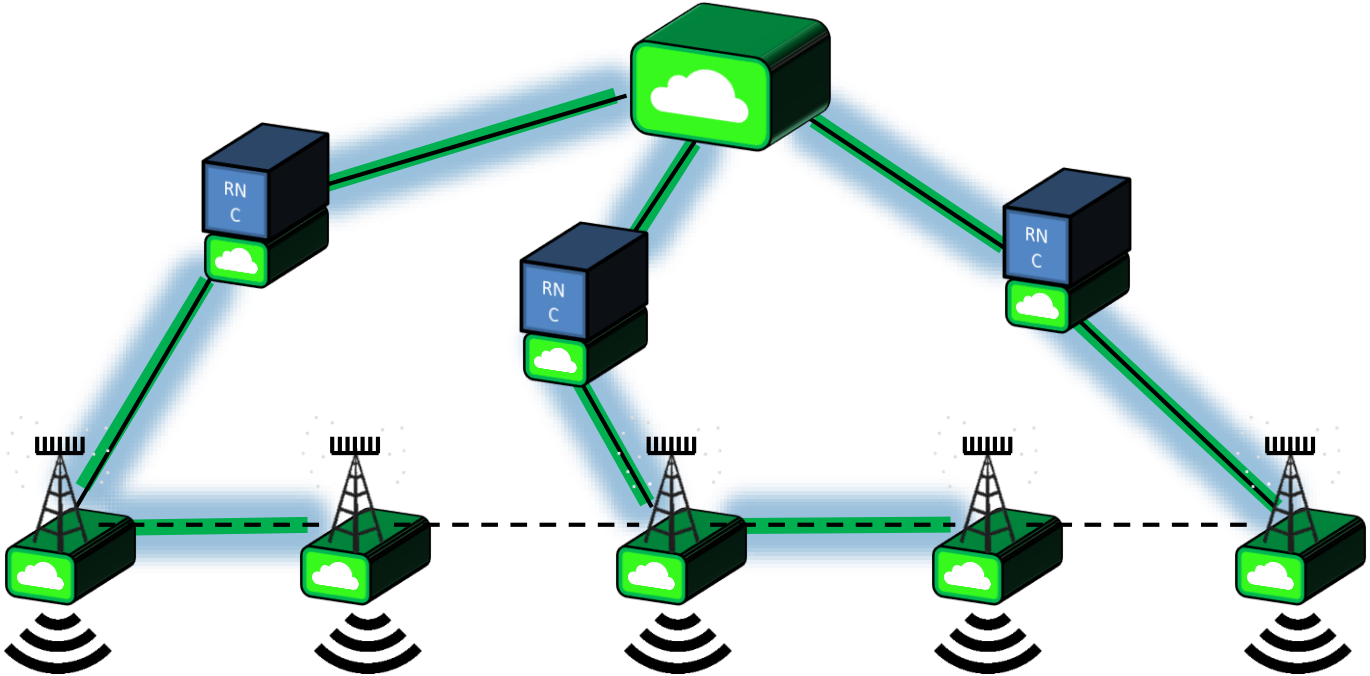
- Heterogenity (4 clouds)
- Clouds behave differently



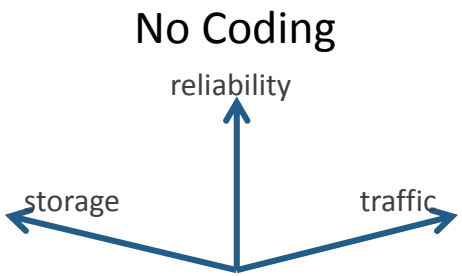
- Speed-Up (5 clouds)
- RLNC does not need full degree of freedom

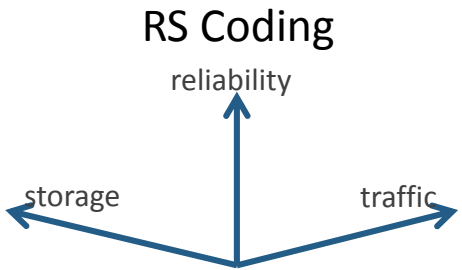


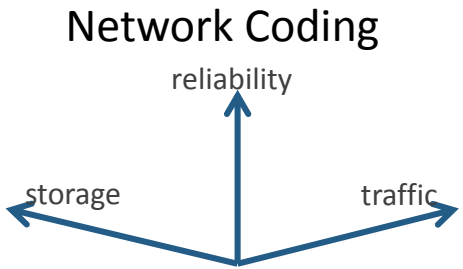
Mobile Edge Cloud / Micro Cloud / Cloud

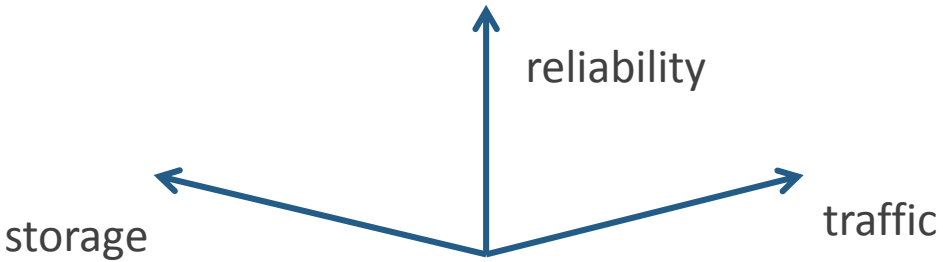


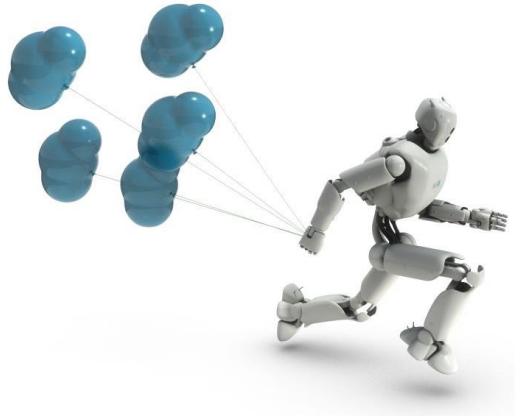
Dynamic Distributed Cloud











Dynamic Distributed Cloud

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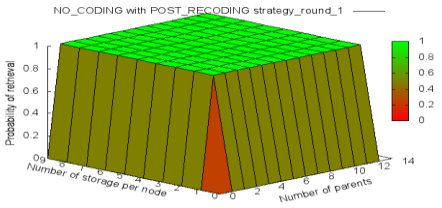
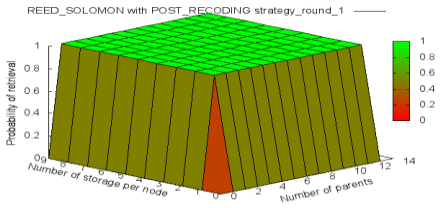
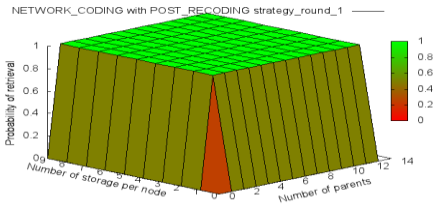
No Coding

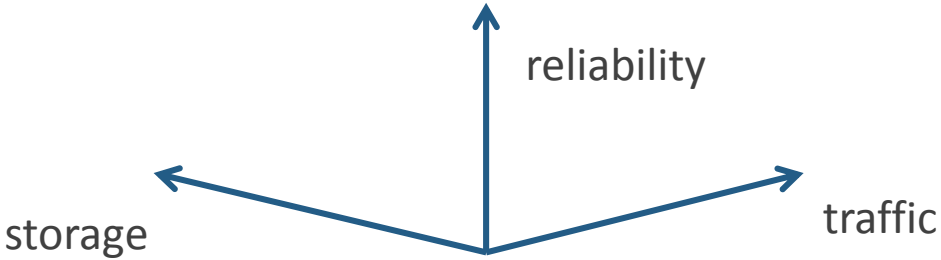


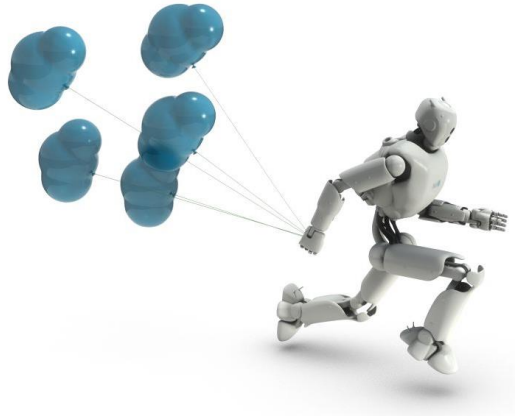
RS Coding



Network Coding







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Thank you

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