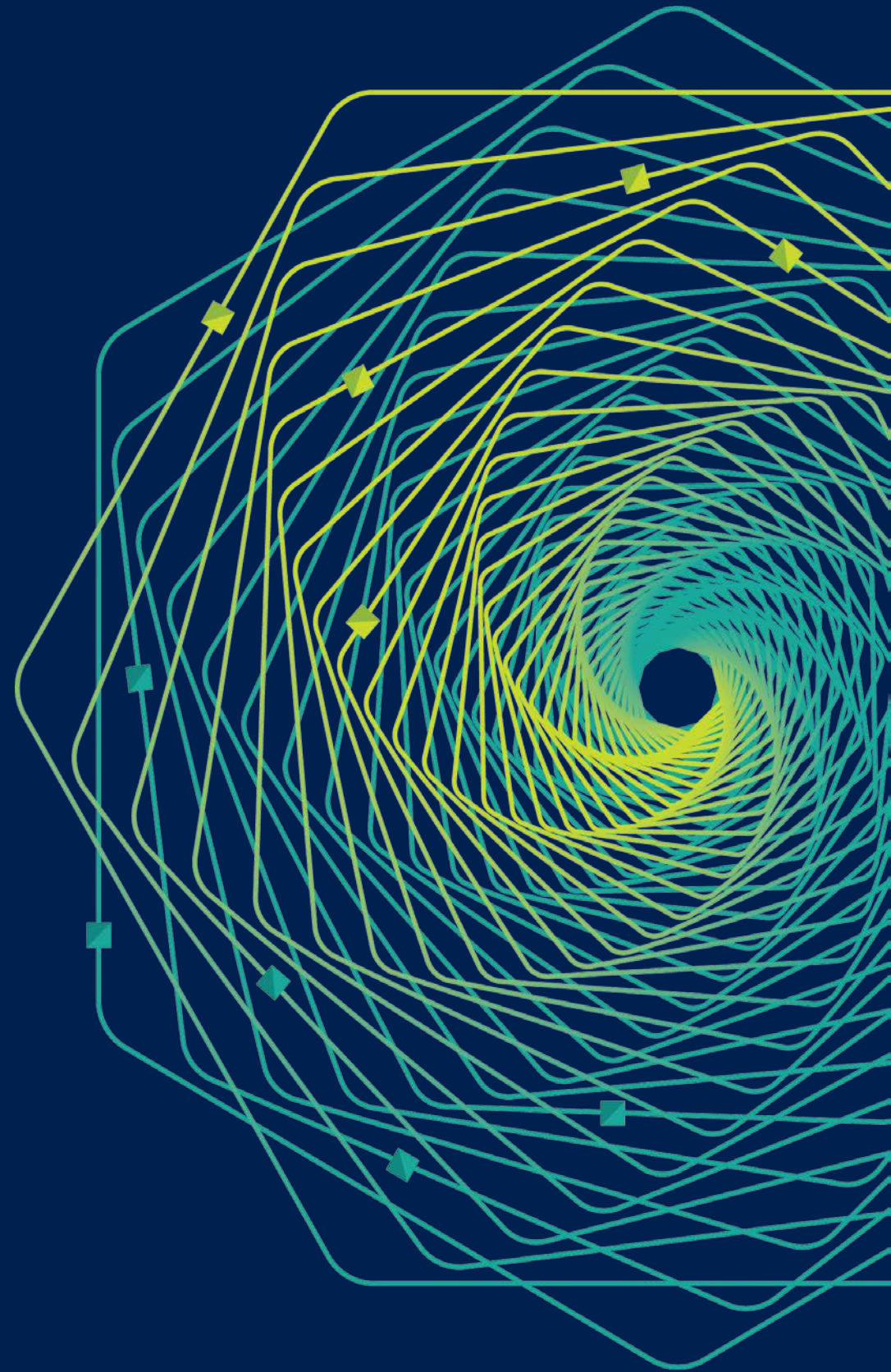




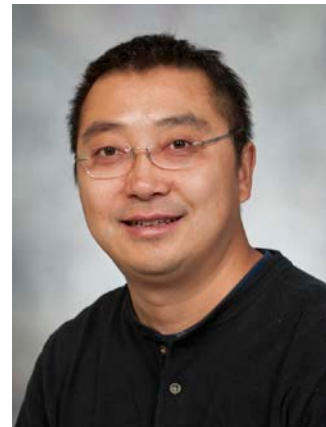
Research Faculty Summit 2018

Systems | Fueling future disruptions



5G is a **Software** Play

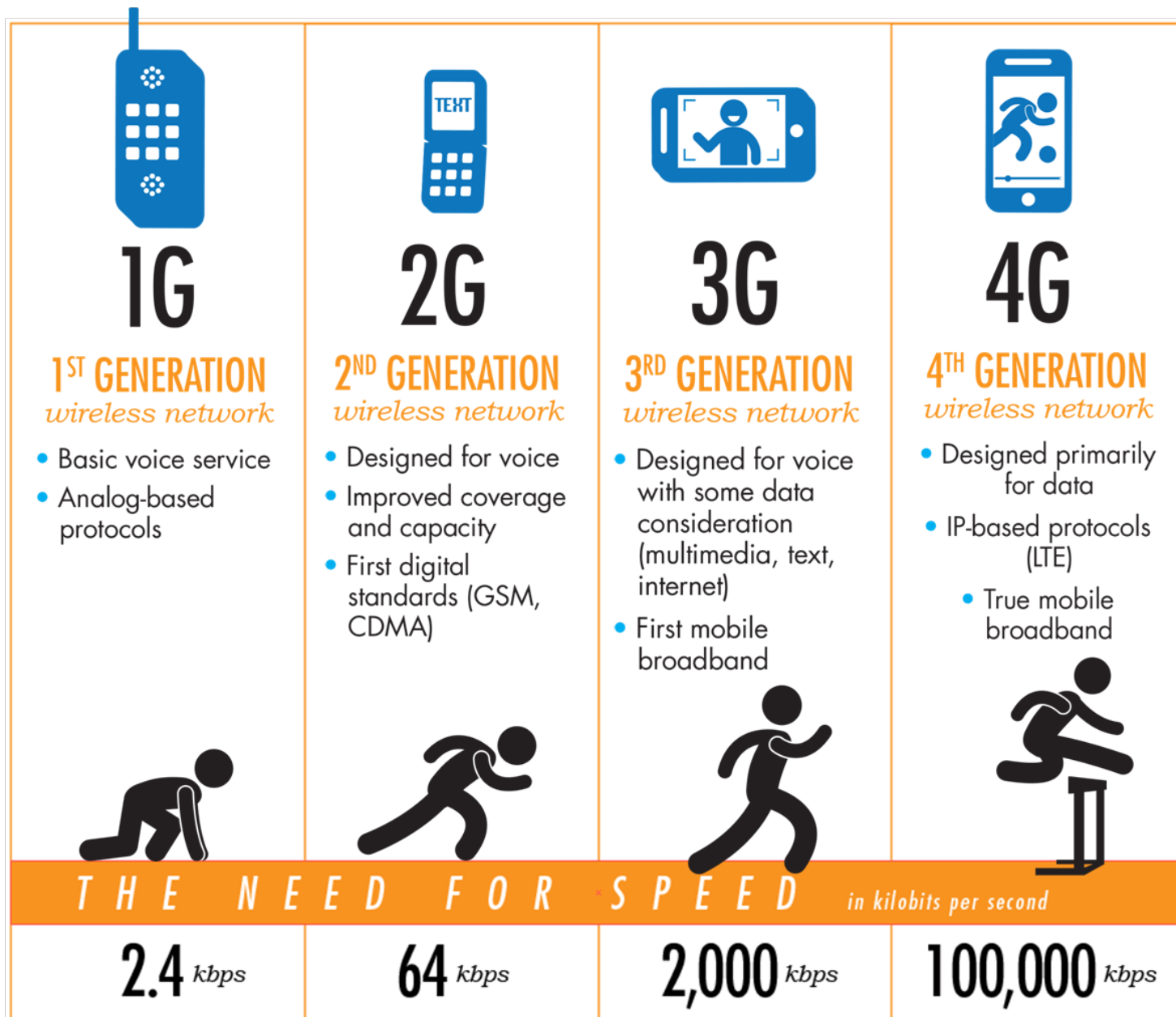
Edge-Cloud will Power Tomorrow's Wireless



Kyle Jamieson* and Lin Zhong**

*Princeton University **Rice University

Are we ready?



5G

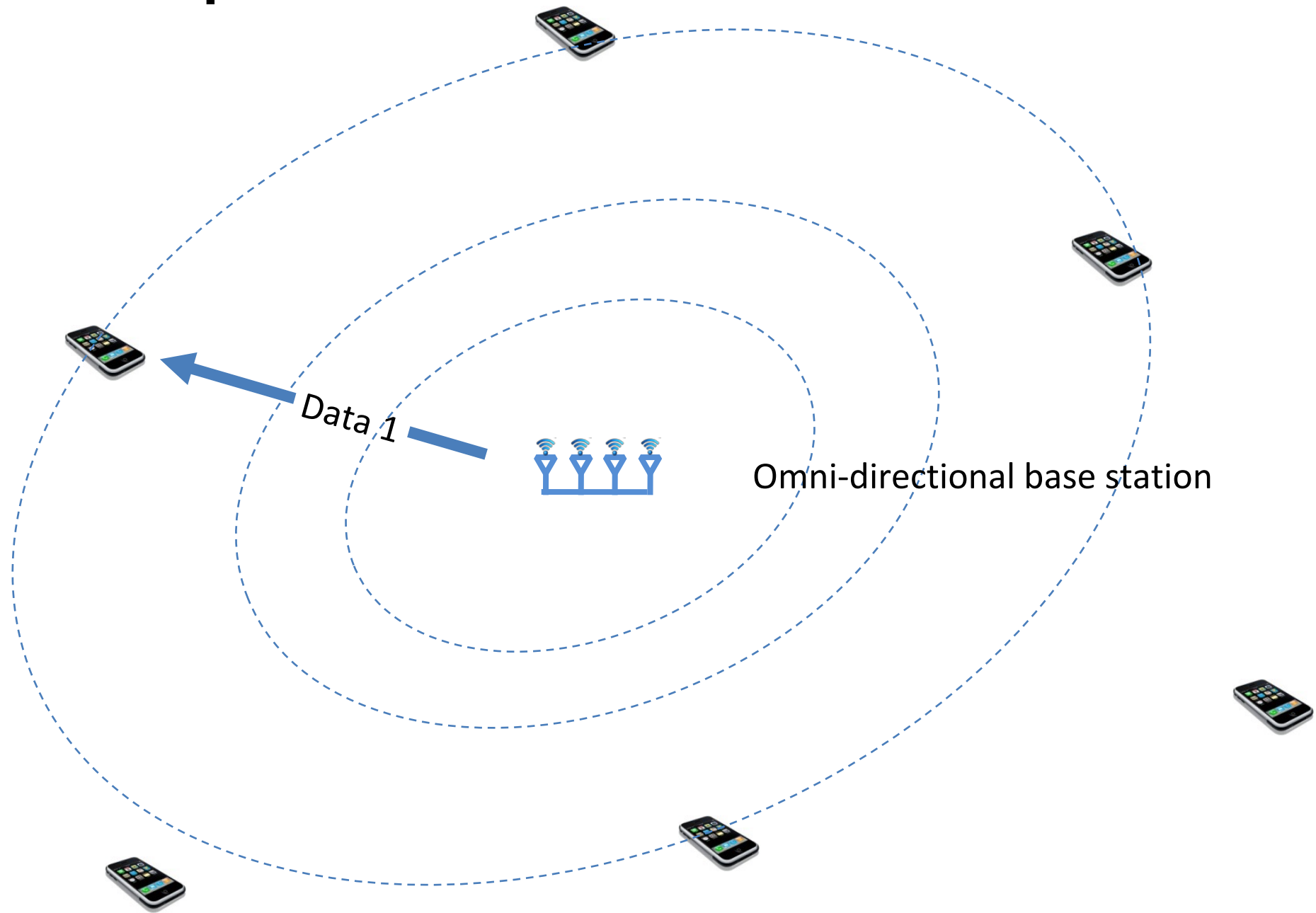
Takeaways

- Software enables **rapid innovation** in telecom
- Rethink software stack for **efficiency** and **availability**
- **Re-architect** the Edge Cloud for 5G networks
- Explore novel **value-added services**

Hardware is cheap and getting cheaper

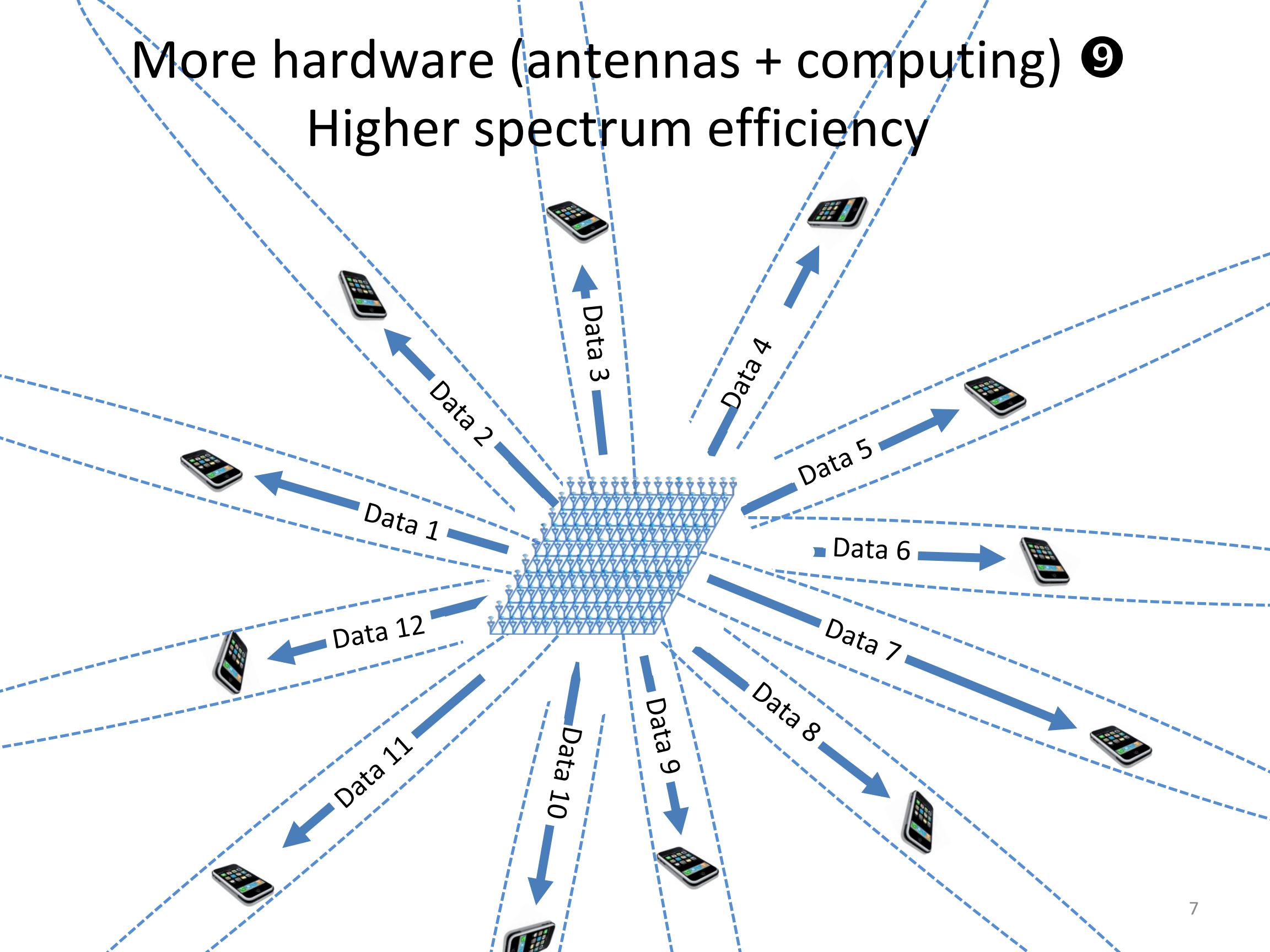
(even post Moore's Law)

Spectrum is scarce



Poor spatial reuse; poor power efficiency; high inter-cell interference

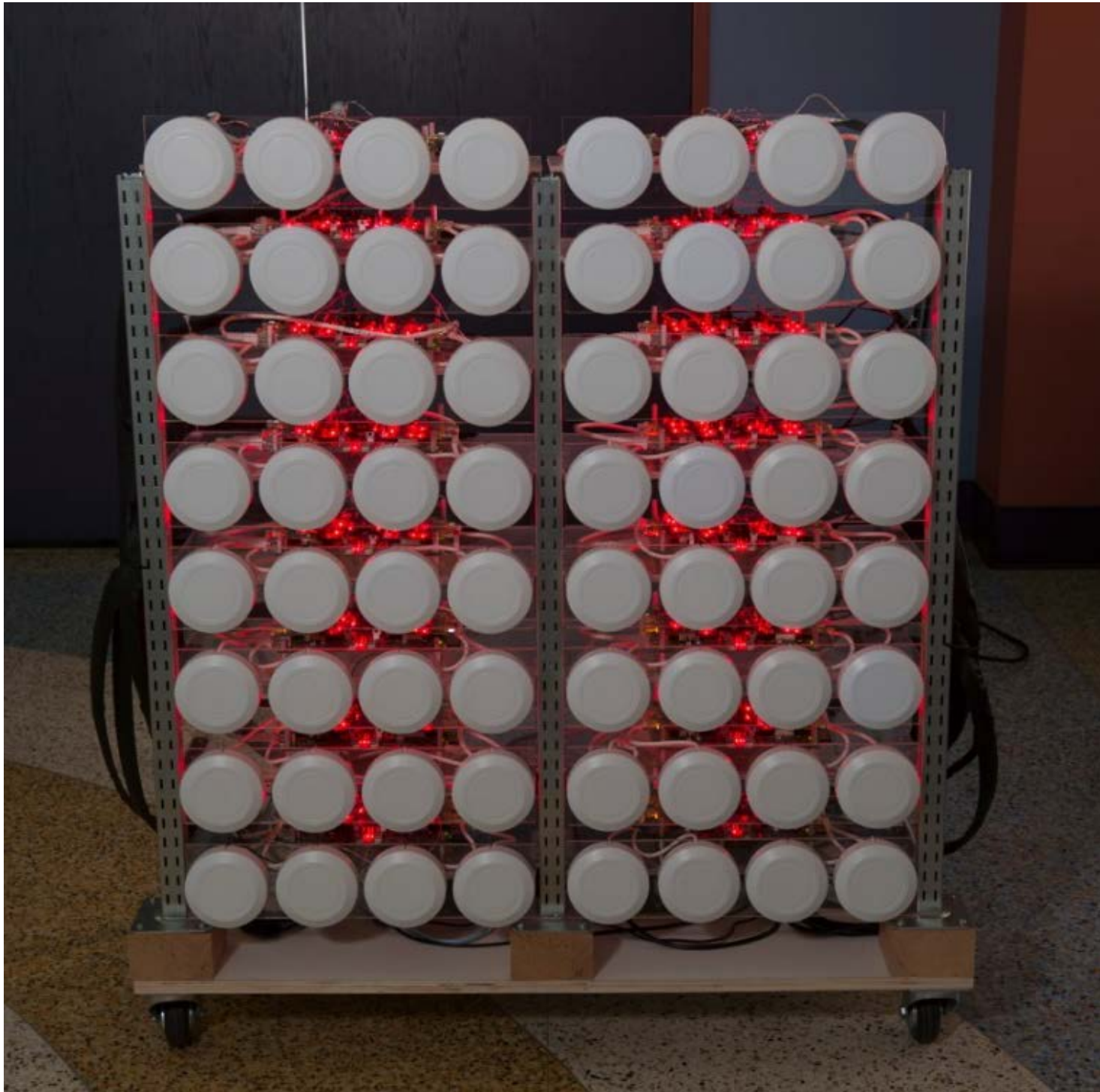
More hardware (antennas + computing) ⑨
Higher spectrum efficiency

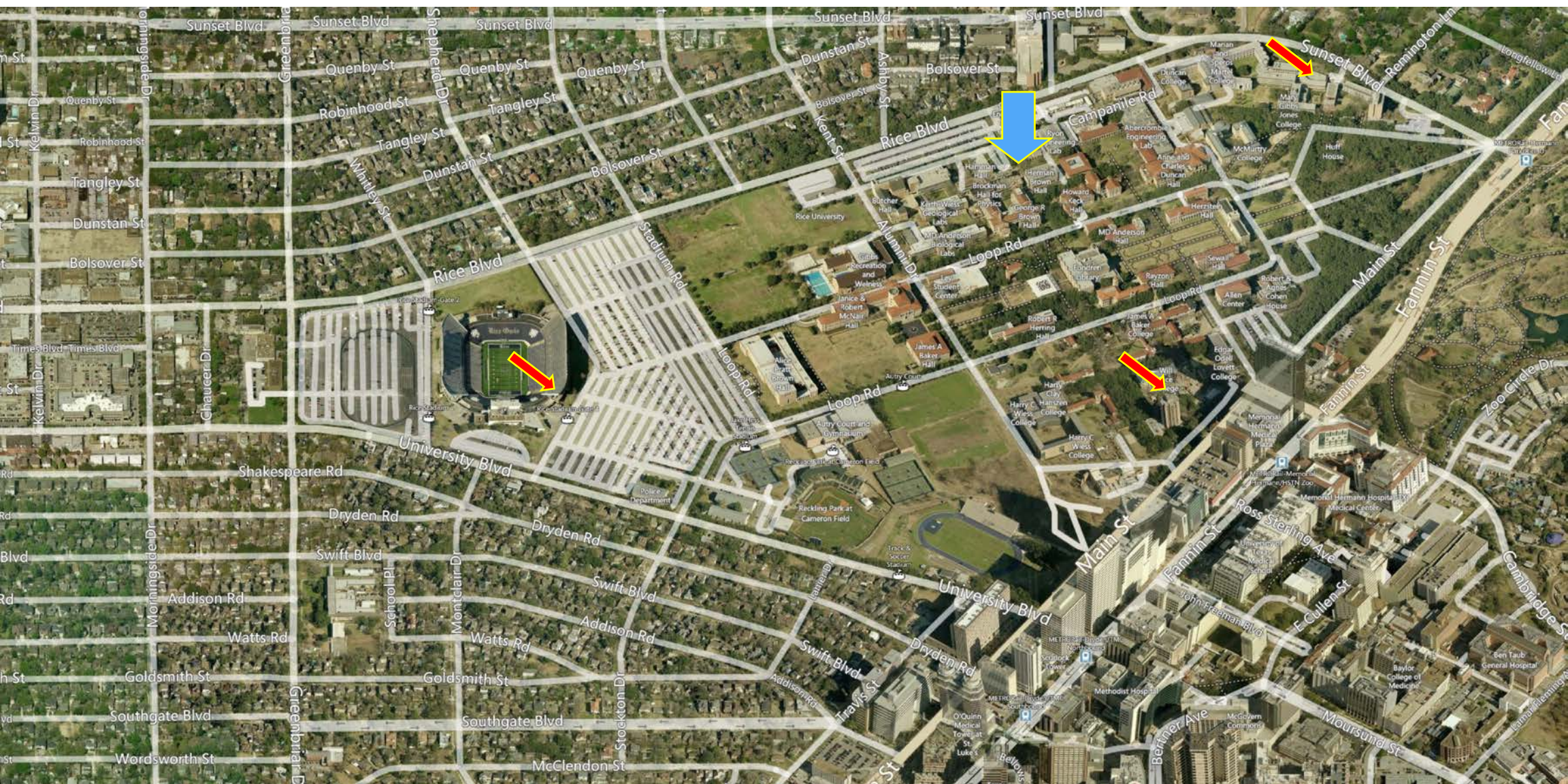


5G: more hardware, higher spectral efficiency, lower latency

- Massive MIMO
- Small cell/dense deployment
- mm-Wave radios

Argos V1 (2011): World's first Massive MIMO Testbed









NATIONAL SCIENCE
FOUNDATION PRESENTS

Platforms for Advanced Wireless Research

TESTBED

POWDER-RENEW



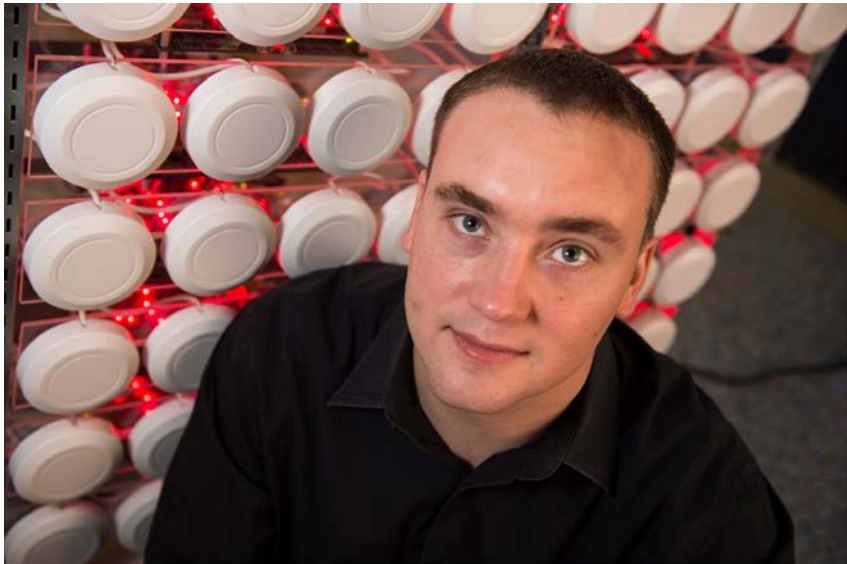
Salt Lake City, UT

PAWR PROJECT OFFICE

 **usignite** Northeastern University

It took seven years!

2011

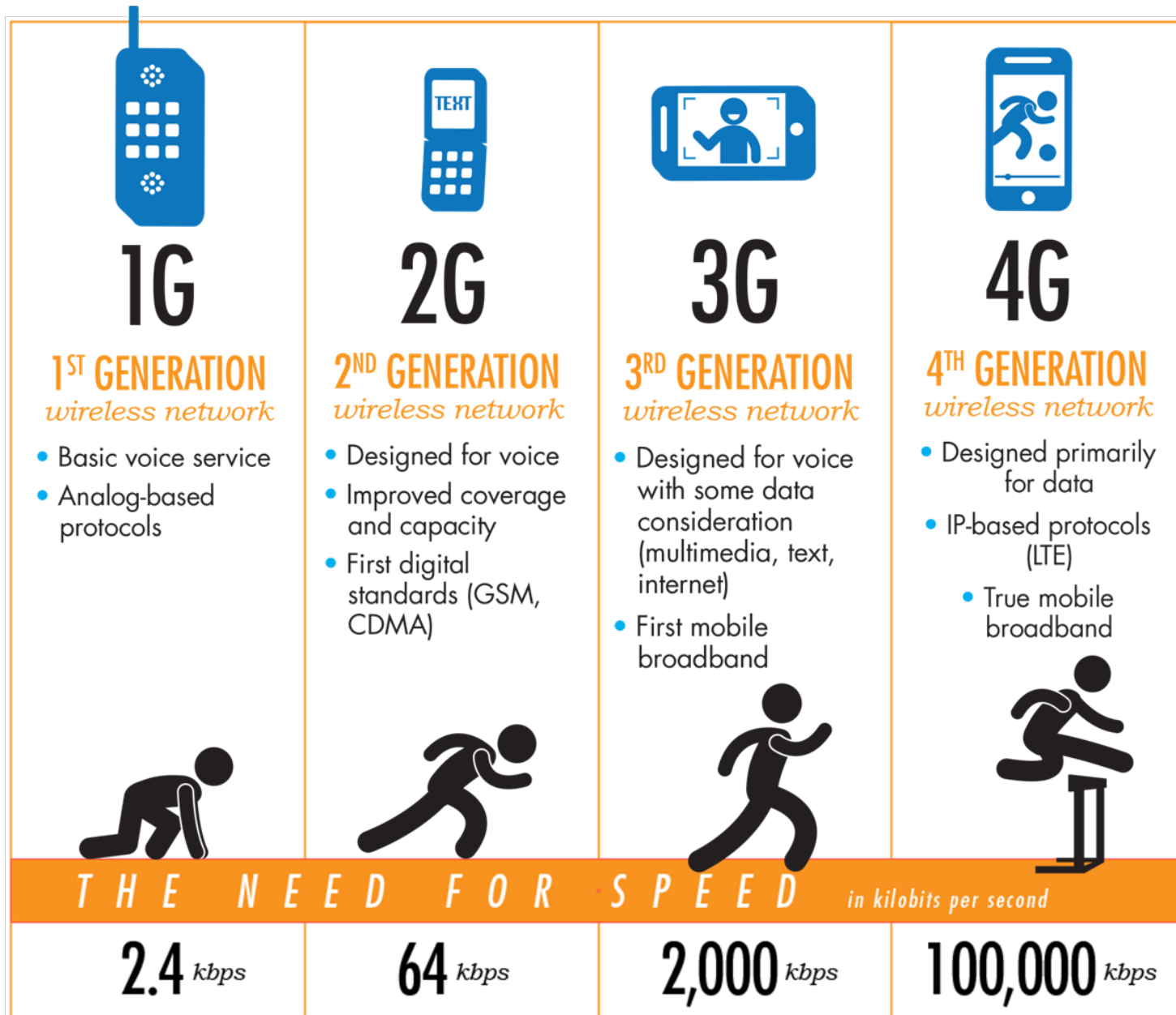


Ph.D. 2017



Skylark Wireless
CTO

Specialized equipment => Slow innovation



5G

Specialized equipment => Slow innovation

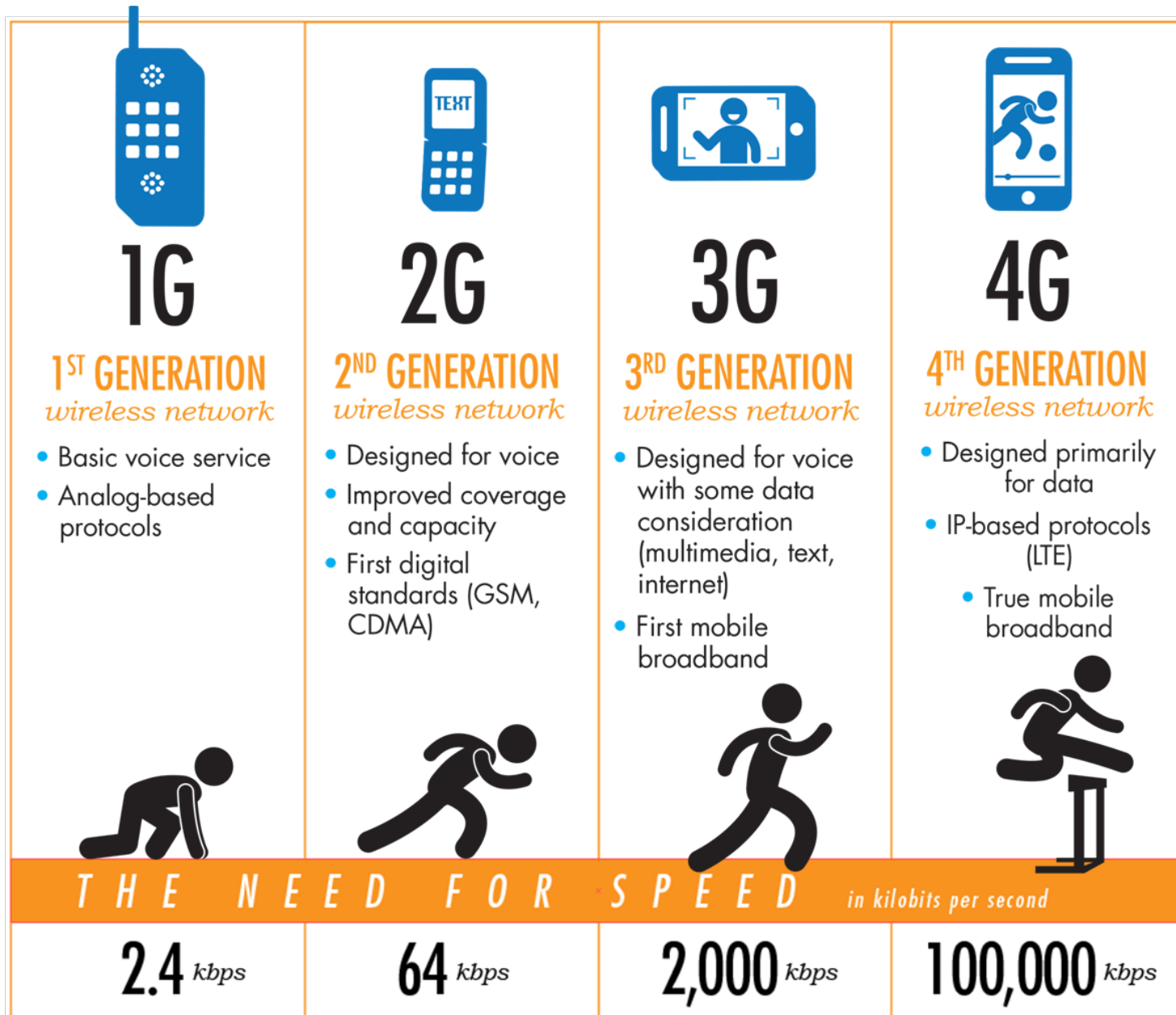
1980s

1990s

2000s

2010s

2020s



5G

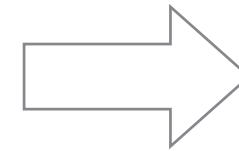
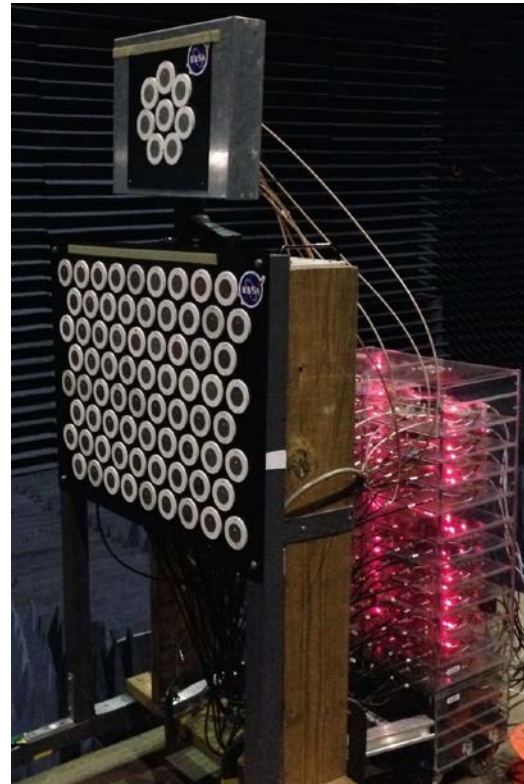
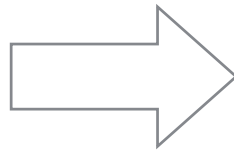
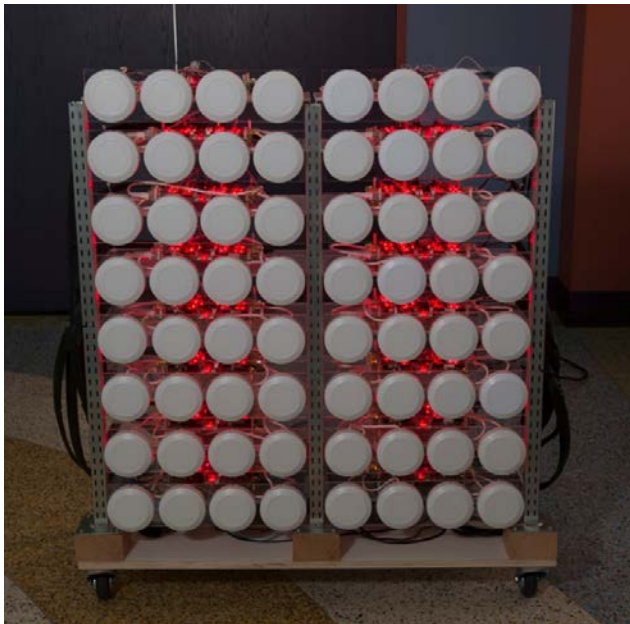
5G infrastructure
needs a **software**
approach

Lessons:

#1: **Software** innovates **faster**

#2: Resource **integration** is
bad

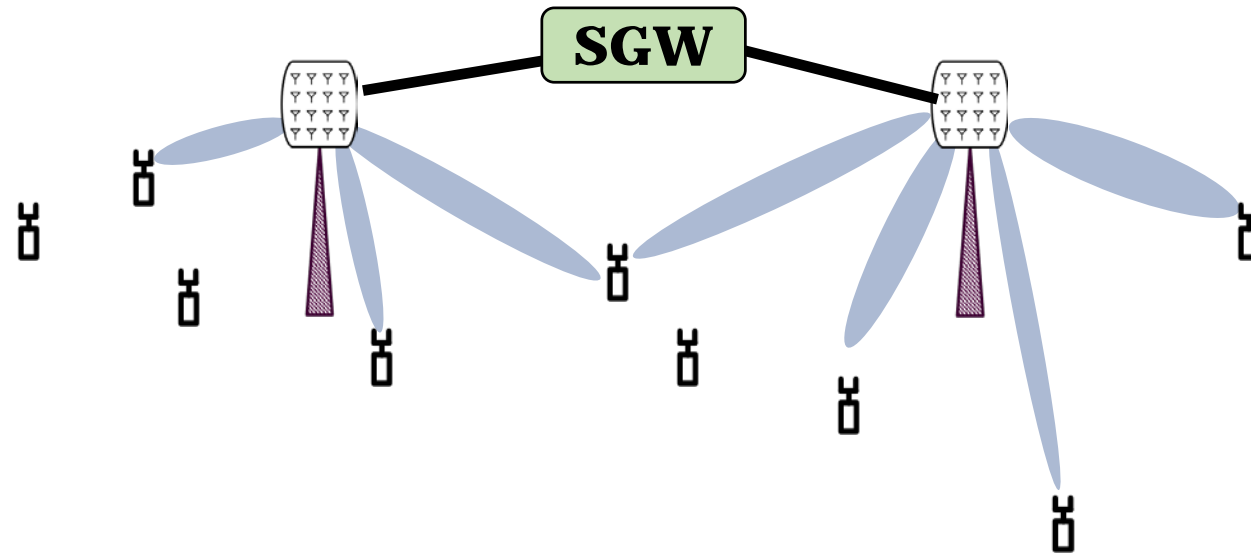
Basestation=RF+Accelerator+software



18



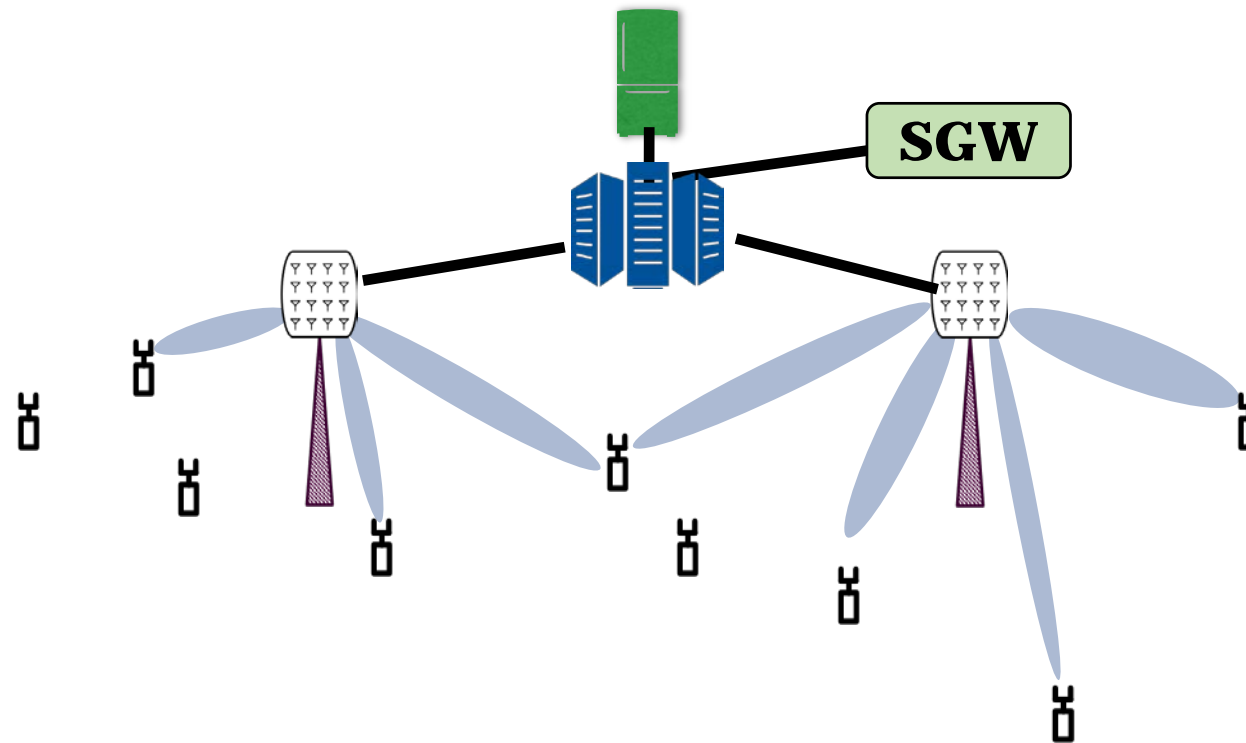
- Slow technology evolution
- Impossible inter-cell resource sharing
- Difficult inter-cell coordination



Basestation=RF+Accelerator+Software
e

Disaggregated radio access

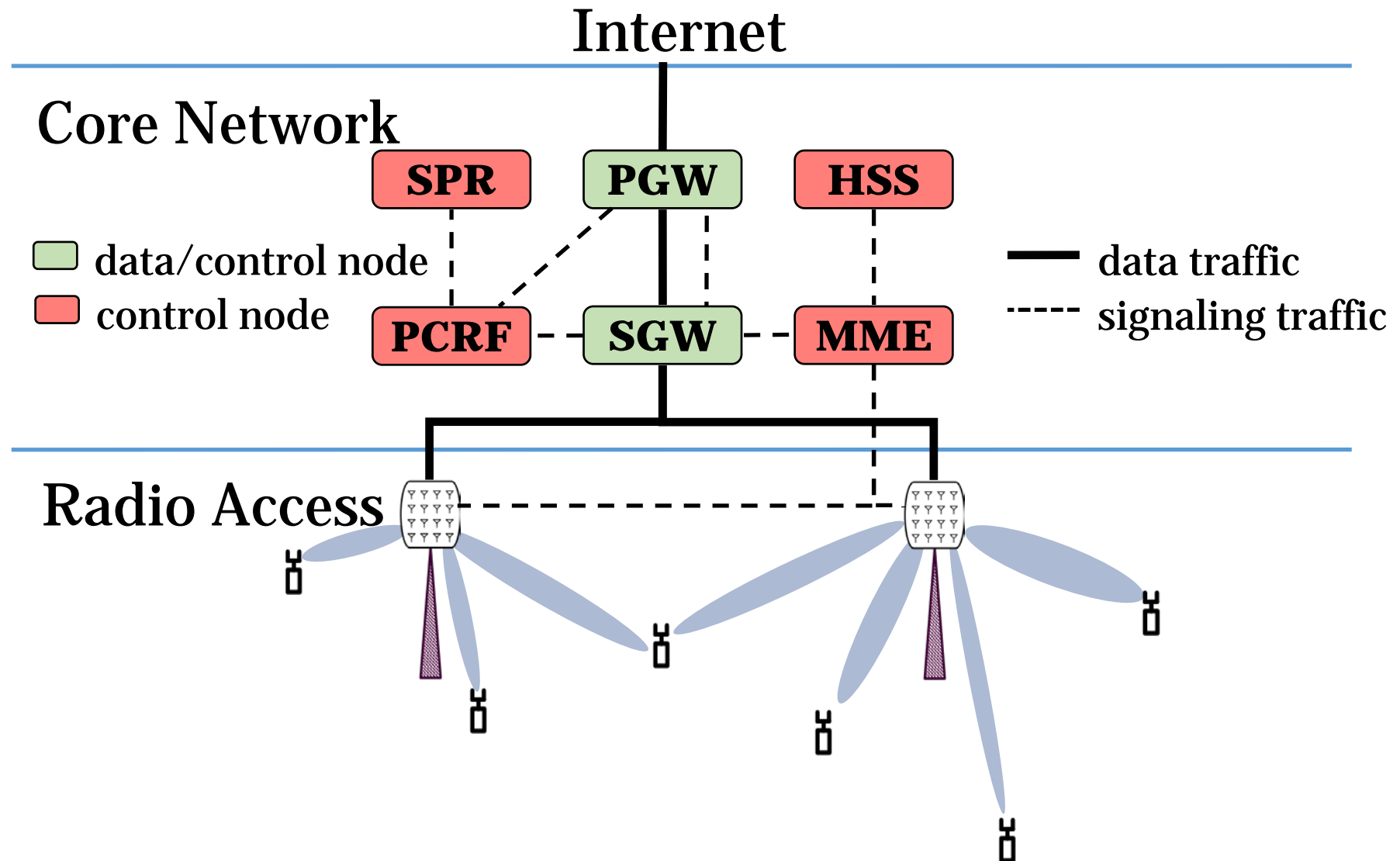
Disaggregated local data center=
Accelerator + Software



Basestation=~~RF+Accelerator+Software~~
e

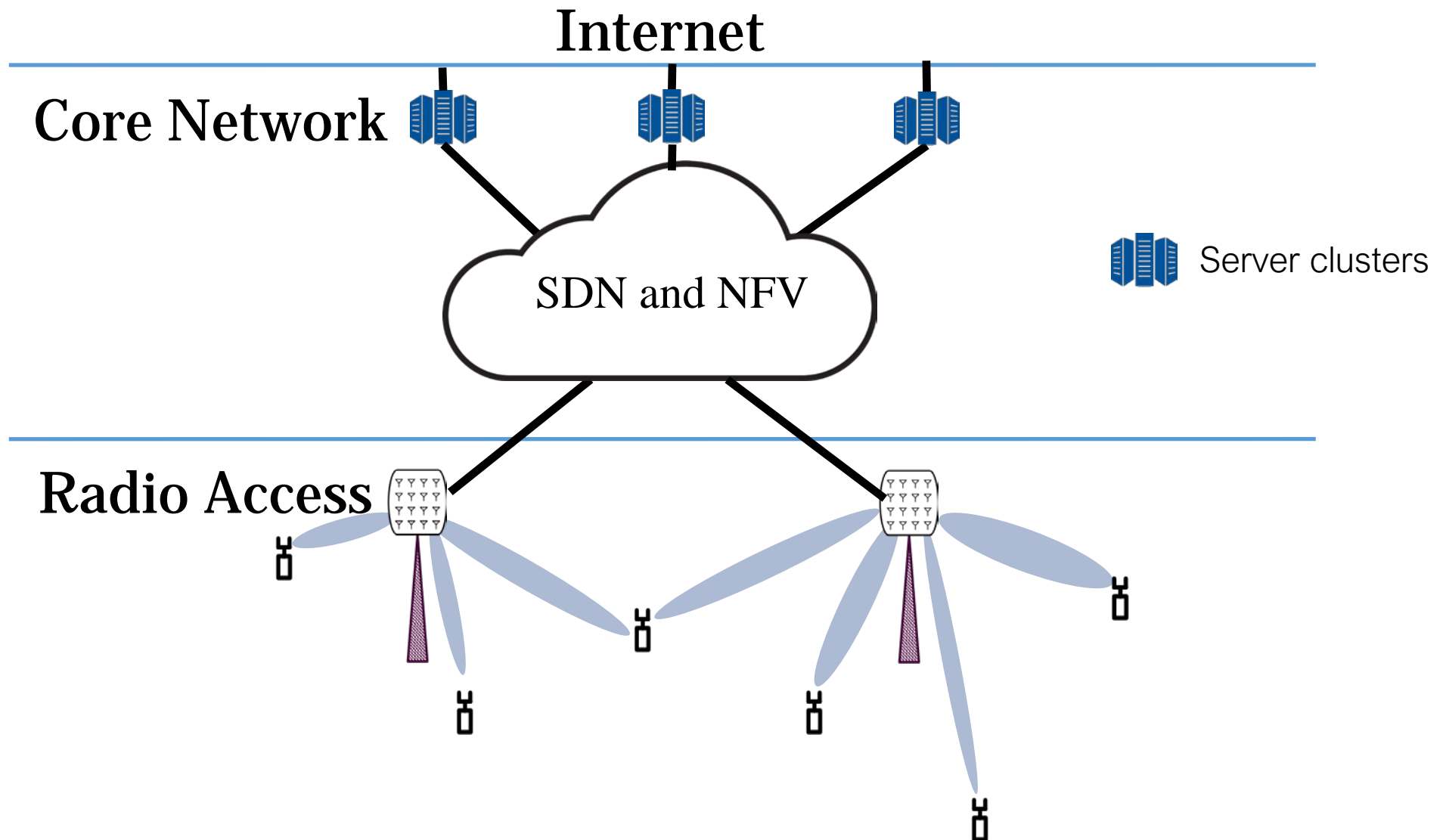
Cellular network recent past

Small cell, MU-MIMO, inter-cell coordination



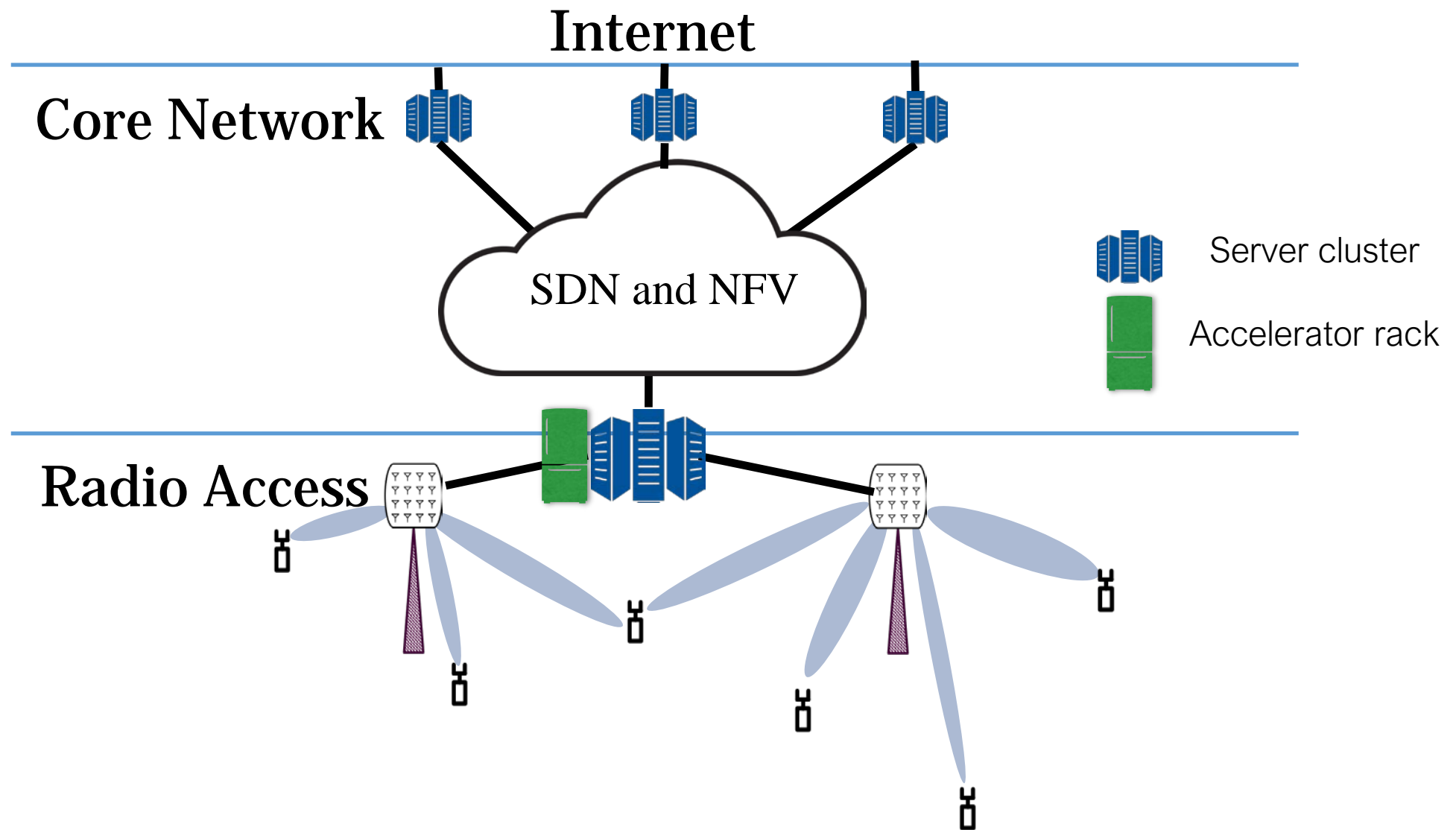
Cellular network today

Software has already eaten Internet and cellular core
Small cell, massive MIMO

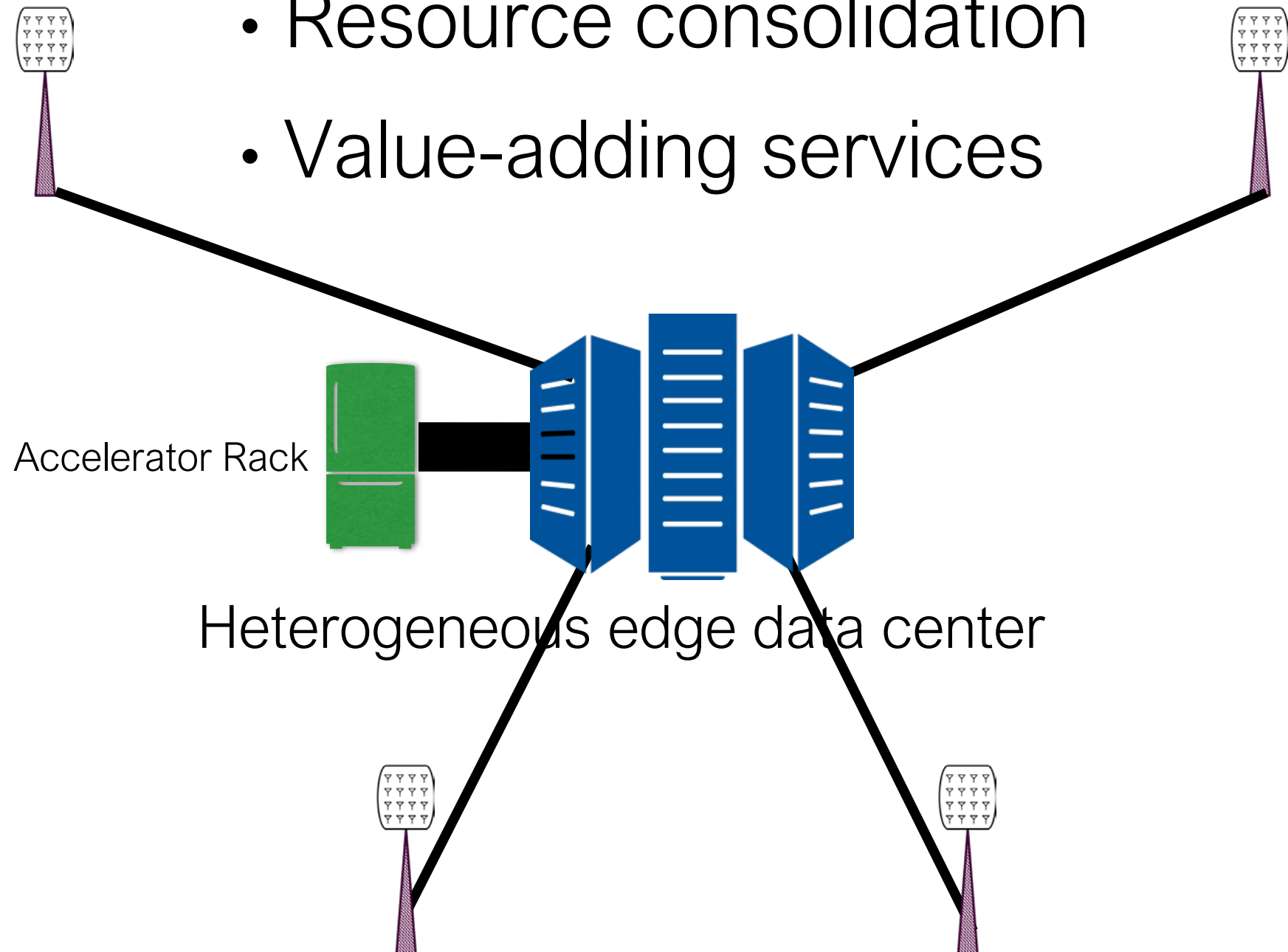


Cellular network tomorrow

Disaggregated local data centers

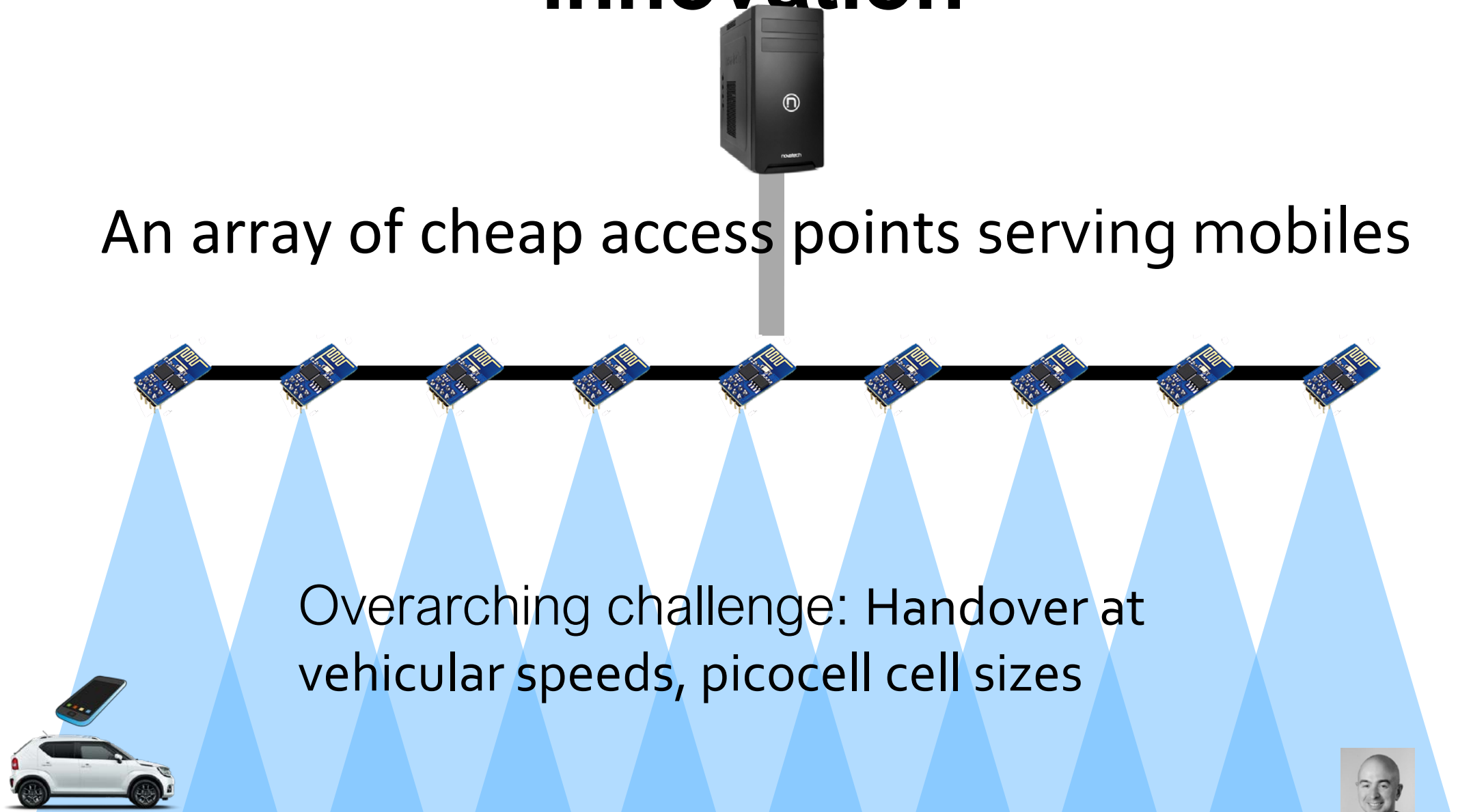


- Fast technology evolution
- Resource consolidation
- Value-adding services



Software enables inexpensive **dense deployment** and **fast innovation**

An array of cheap access points serving mobiles



Song et al (SIGCOMM'17)



ParkMaster: Smartphone-based on-the-road parking intelligence



- Close to zero-cost system for parking availability monitoring
- In-frame car localization algorithm
- Lightweight car tracking algorithm

Grassi et al (SEC 2017)



Continuous mobile vision



2012



Continuous mobile vision



2012



Continuous mobile vision

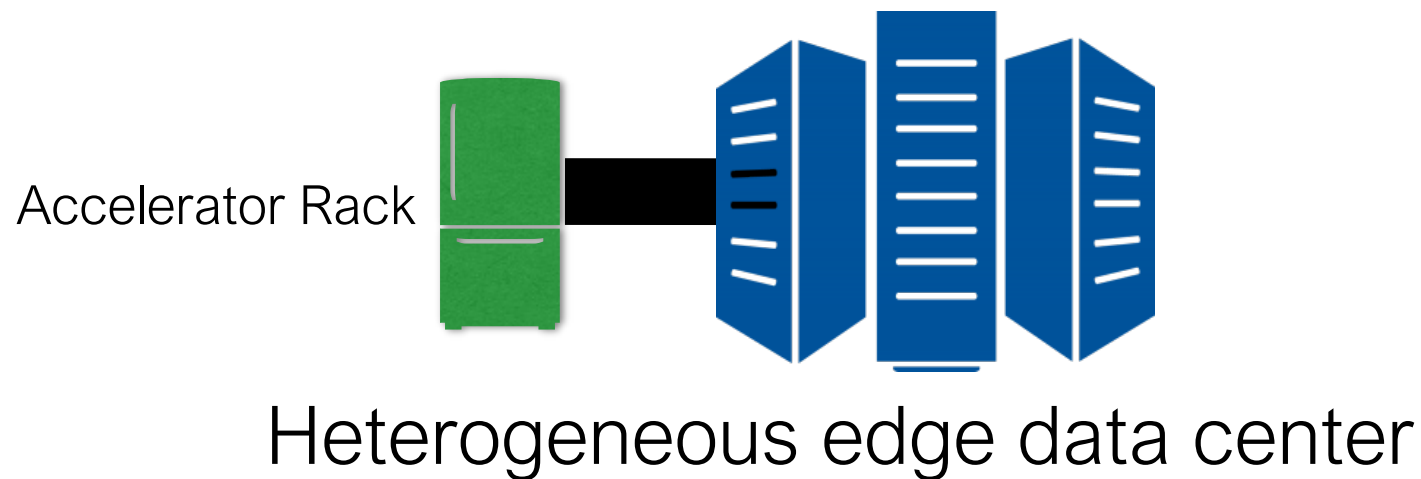


2020

Software systems must be

Efficient (like baremetal)

Available (like commodity data center)



FlexCore, NSDI'17

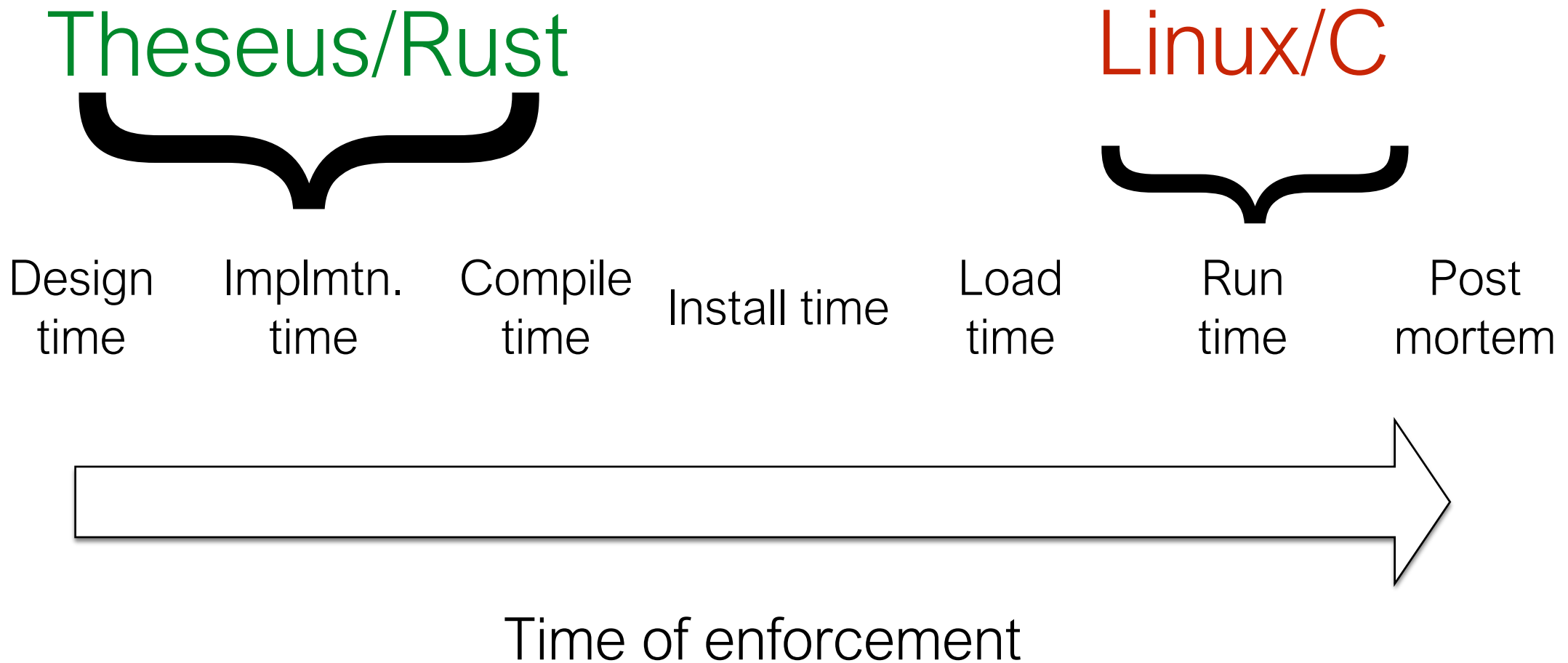


Rethink the software
stack for **efficiency &
availability**

Linux is **fundamentally
flawed** for these goals

- C is not safe
- Weak modularization

If Linux/C is airport security check
we need TSA Pre



Inspired by Hunt & Larus (2004)

5G is a **Software Play**

- Software enables **rapid innovation** in telecom
- Rethink software stack for **efficiency** and **availability**
- **Re-architect** the Edge Cloud for 5G networks
- Enable novel **value-added services**

Thank you!

