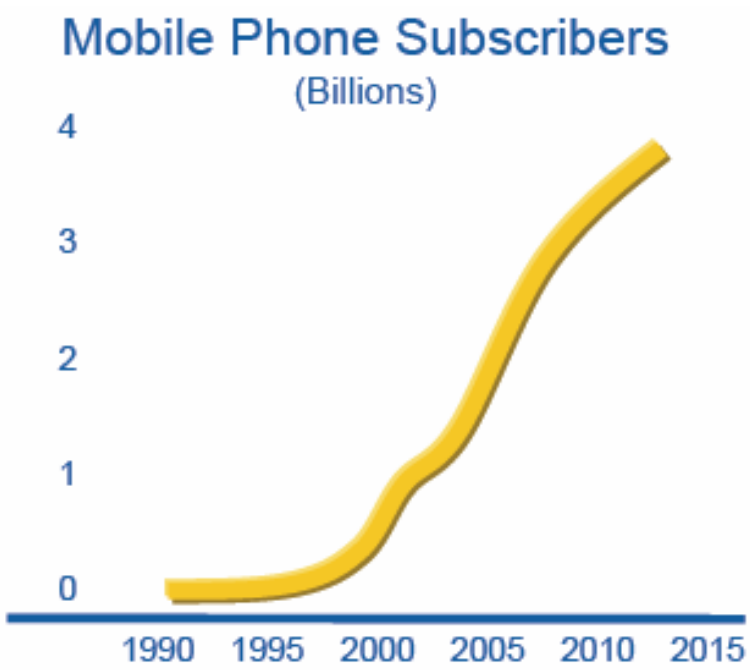
Programmable Open Mobile Internet 2020

Guru Parulkar

Stanford Clean Slate Internet Design Program

Revolution in Mobile Computing
Millions → Billions



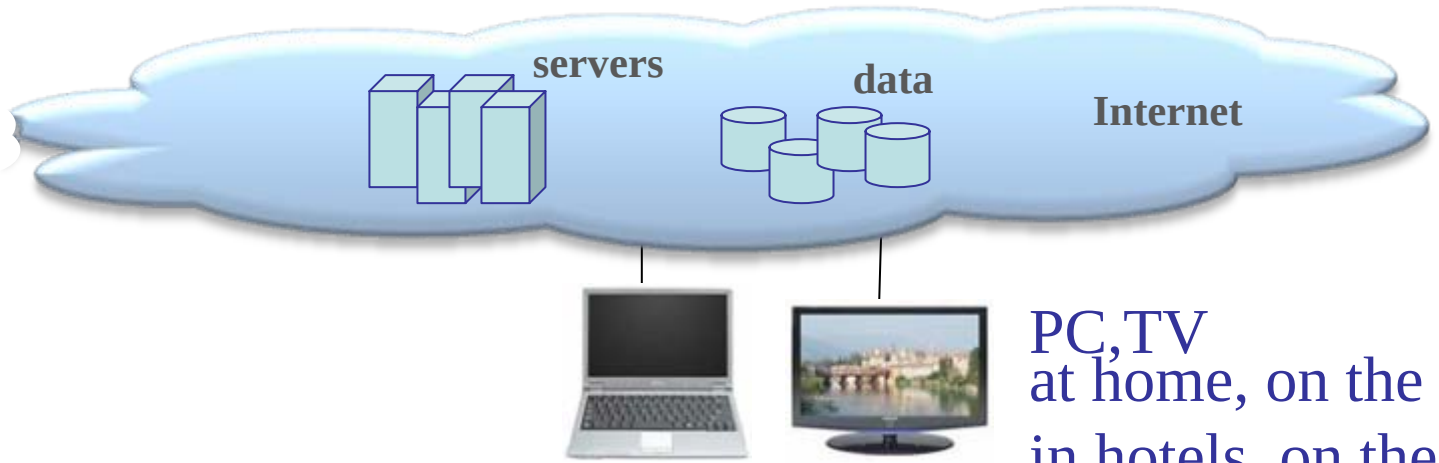

Democratization of computing


Entirely new uses of mobile computing

Power-limitation of handheld ⇨ computation will move to the cloud

Need to back up and refresh our lost data ⇨ data will move to the cloud

Vision: Three Tiers of Computing



PC,TV
at home, on the road,
in hotels, on the plane

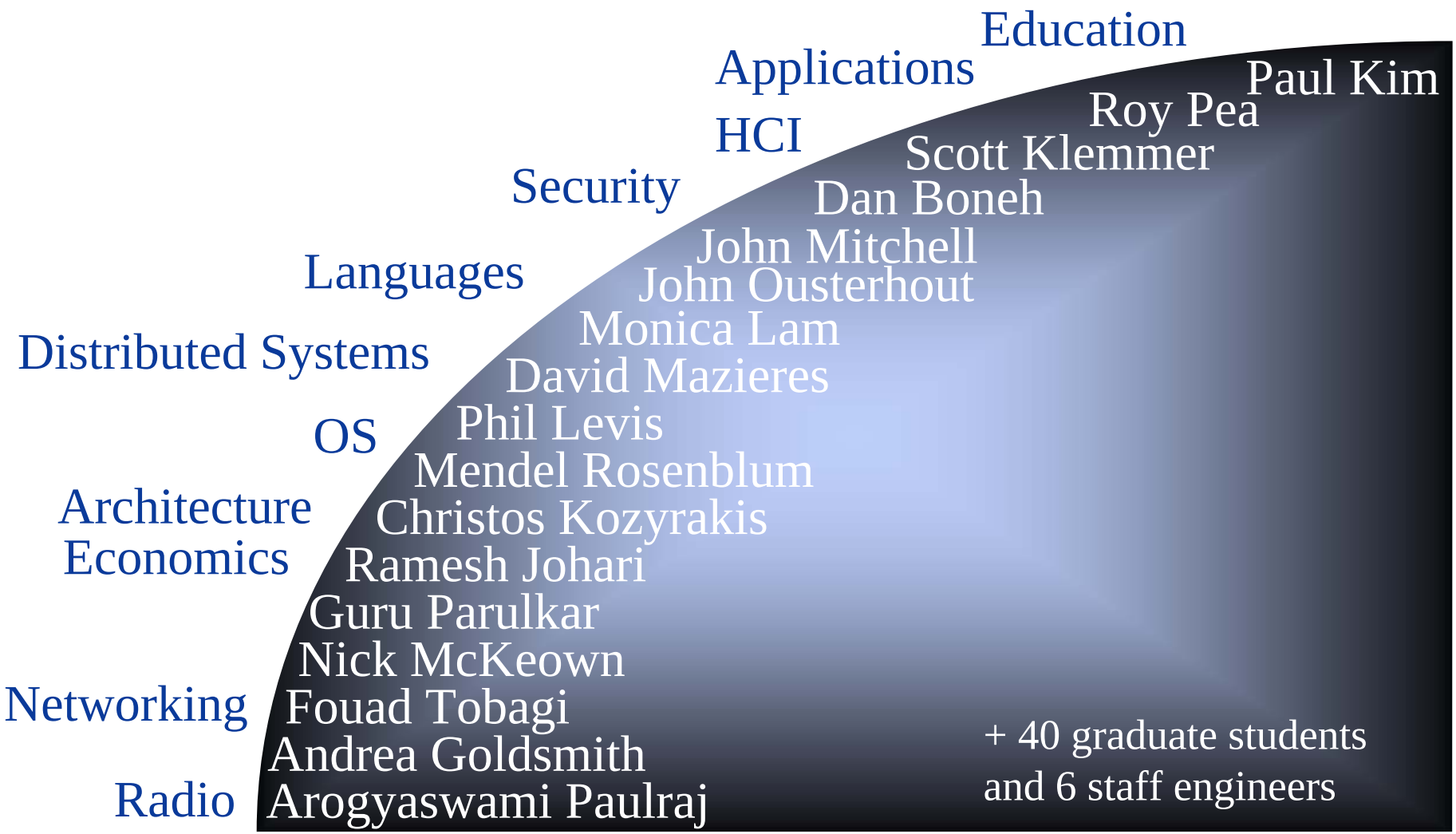
Borrow the display, keyboard, memory, etc

Great opportunities

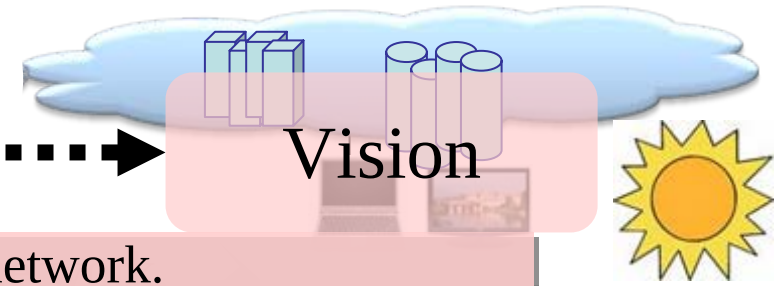
- Revolution in Mobile Computing will change our field.
- Opportunity to bring change before ossification.

Make payments, open physical locks

Stanford Team



Today



Vision

- Problem with the network.
- 3G: Cellular networks ⇨ IP
- IP: Bad for mobility, security, management
- Need a network that continually evolves

Where we
will go otherwise

Barriers

1. Big-brother portals will own our data
2. We will be locked-in to applications
3. Wireless capacity will stay closed
4. Network will stay ossified

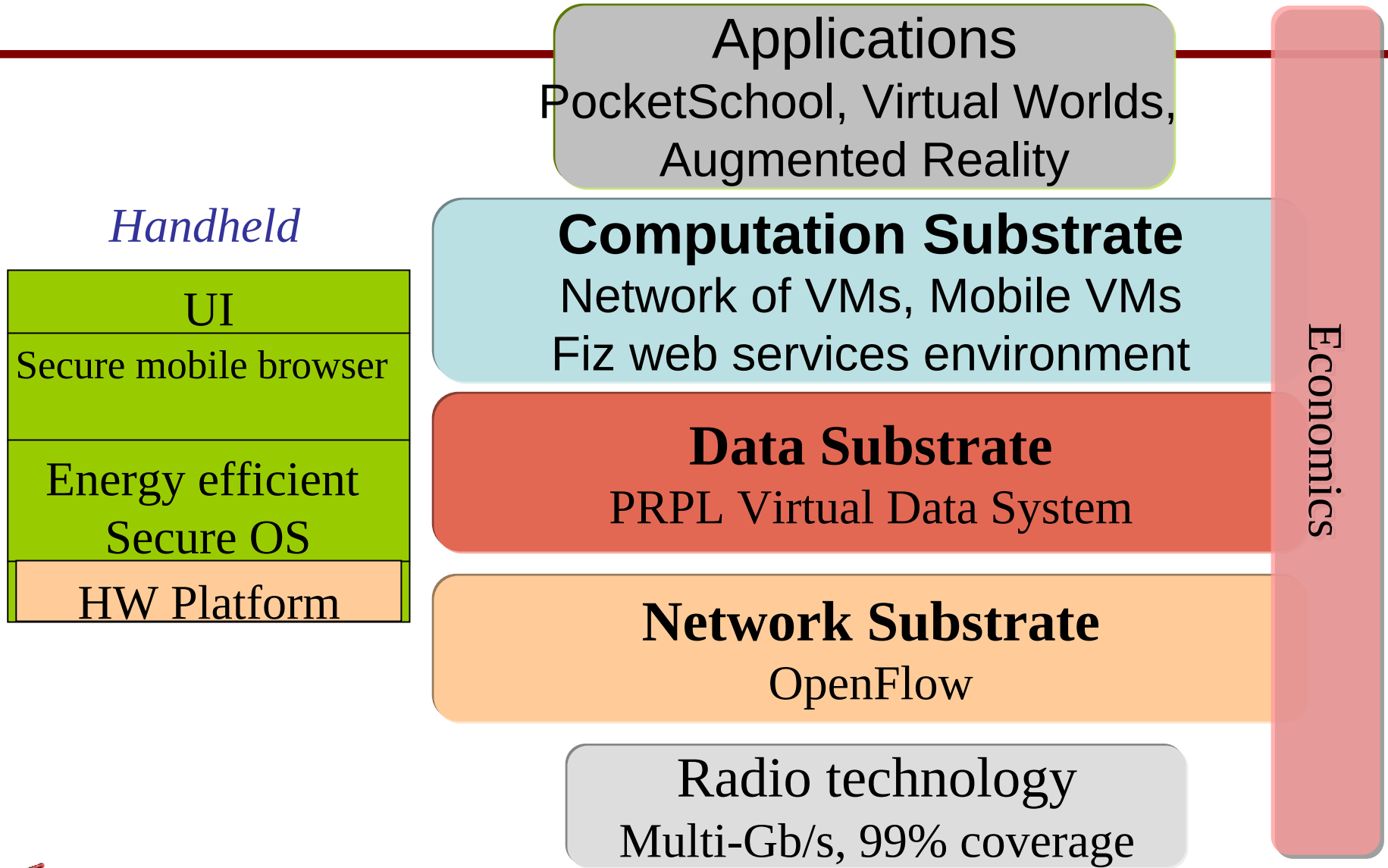
Our Approach

To reinvent Internet infrastructure and services

by creating “platforms for innovations” in networking, computing, and storage and making them available to research and user communities

with emphasis on mobile computing

The Big Picture



The Big Picture

Learn more

Nick McKeown

Guru Parulkar

http://OpenFlowSwitch.org

Handheld

UI

Secure mobile browser

Energy efficient Secure OS

HW Platform

Applications

PocketSchool, Virtu… Augmented R…

Network of VMs, Mobile VMs

OpenFlow

- Continued innovation by users, owners and operators
- Easy to experiment with mobility, security and mgmt

PRPL Virtual Data System

Network Substrate

OpenFlow

Radio technology

Multi-Gb/s, 99% coverage

Economics

The Big Picture

Learn more

Monica Lam

Handheld

UI

Secure mobile browser

Energy efficient Secure OS

HW Platform

PRPL Platform

- Allow users to control who can access and mine their data
- PRPL protocol allows services to be separated from data
- We can choose where our data resides

Data Substrate

PRPL Virtual Data System

Network Substrate

OpenFlow

Radio technology

Multi-Gb/s, 99% coverage

Economics

T

VM as granularity of computing

- Large services built from 100s or 1000s of VMs
- VMs stay seamlessly connected, tracking users
- Made possible by OpenFlow

Handheld

UI

Secure mobile browser

Computation Substrate

Network of VMs, Mobile VMs

Fiz web services environment

Data Substrate

Network Substrate

OpenFlow

Ecosystem

Network of VMs

Mendel Rosenblum

Fiz environment

John Ousterhout

Radio technology

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The Big Picture

Applications

PocketSchool, Virtual Worlds, Augmented Reality

OS

- Make users aware of how they use energy
- Energy management per thread
- Integrate with Information Flow Control
- “Capacitors”

ation Substrate

f VMs, Mobile VMs

rvices environment

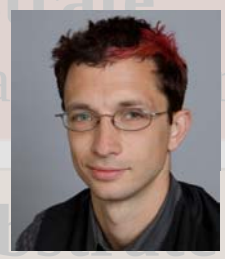
Energy efficient Secure OS

HW Platform

Learn more

Phil Levis

David Mazieres



Data Substrate

Network Substrate

OpenFlow

Economics

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The Big Picture

Applications

PocketSchool, Virtual Worlds, Augmented Reality

Secure Mobile Browser

- Build on hugely successful work
- Exploit the move from desktop to mobile browsers

Computation Substrate

Network of VMs, Mobile VMs

Fiz web service management

Secure mobile browser

Energy efficient Secure OS

HW Platform

Learn more

Dan Boneh

John Mitchell

Data Su

PDPL Virtual

Economics

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Radio technology

Multi-Gb/s, 99% coverage

The Big Picture

User Interface

- New poplations of users
- Need to quickly repurpose and test new Uis
- Today's technology is rudimentary
- Decouple UI from application

Handheld

UI

Secure mobile browser

Energy efficient Secure OS

HW Platform

Applications

PocketSchool, Virtual Worlds, Augmented Reality

Computation Substrate

Network of VMs, Mobile VMs

Elz web service environment

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Scott Klemmer

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Economics

The Big Picture

Applications
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Handheld

UI
Secure mobile browser
Energy efficient Secure OS
HW Platform

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A. Paulraj

Faster radios

- Today: WiMAX gives ~20Mb/s
- 1Gb/s predicted by 2013
- Extrapolating: Set the stage for 10Gb/s
- Need cooperation of handhelds: Distributed MIMO, client relaying, accumulation coding

Economics

Radio technology
Multi-Gb/s, 99% coverage

Learn more

Ramesh Johari

Handheld

UI

Secure mobile browser

Energy efficient Secure OS

HW Platform

Infrastructure owner's dilemma

- Do I lock-in a profitable, known, homegrown service now, knowing others can pass me by?
- Or do I open up my infrastructure, and risk being commoditized?

Network Substrate

OpenFlow

Radio technology

Multi-Gb/s, 99% coverage

Economics

Summary

- **Big changes on the horizon**
  - Opportunity to rethink the Internet infrastructure
- **Stanford's Clean Slate Program**
  - Reinvent the Internet by creating platforms for innovations
- **WEB/Computing substrate: Fiz and network of VMs**
  - Enable scalable, highly interactive, rich media applications
- **Data substrate: PRPL Platform**
  - Separate data from applications in cloud: give control of data to owners
  - Allow any application to use any data under the control of its owner
- **Networking substrate: OpenFlow Platform**
  - Enable users to create their own network services
  - Network services: access control, routing, mobility management, …
- **Handheld software: OS, browser, UI platforms**

Agenda

9:00 - 9:45am Mobile Technologies and Services
-- Jan Uddenfeldt, Ericsson

9:45 - 10:30am Cinder: Energy Aware Secure OS for Mobile Handheld Devices
-- Phil Levis, Stanford

10:30 - 11:00am Break

11:00 - 11:45am Learning Networks of Places and People from Location Data
-- Tony Jebara, Sense Networks

11:45 - 12:30pm Building Social Networking Future without Big Brother
-- Monica Lam, Stanford

12:30 - 1:30pm Lunch

Agenda

12:30 – 2:00pm Lunch

2:00 – 2:45pm Startup Scene in Mobile Wireless
-- Jake Seid and Barry Eggers, Lightspeed Venture

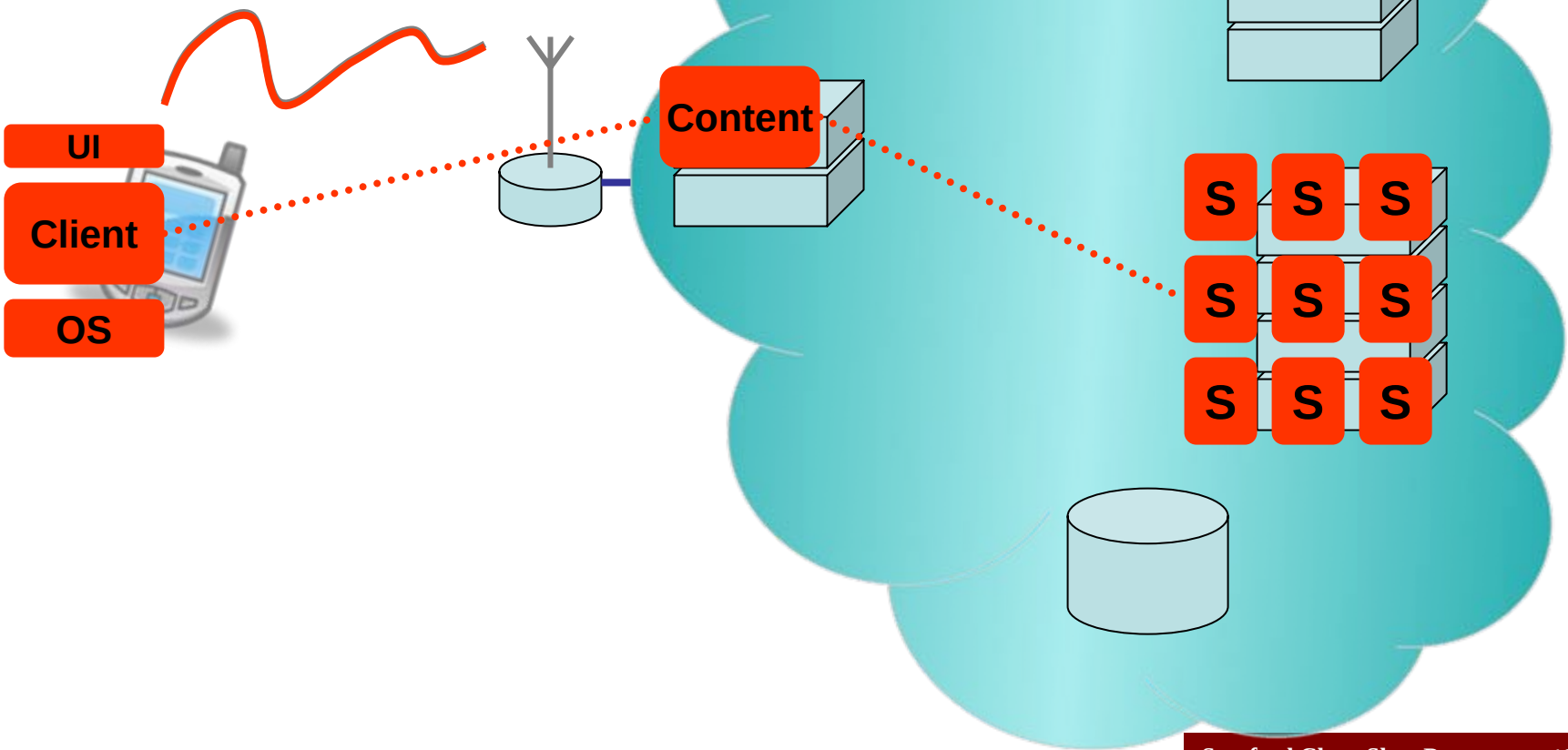
2:45 – 3:30pm Cloud As A Semantic Platform
-- Bob Iannucci, Nokia

3:30 - 4:00pm Break

4:00 - 4:45pm OpenFlow: Networking Substrate to Enable Internet Innovations
-- Nick McKeown, Stanford

4:45 - 5:15pm OpenFlow Demonstrations
-- Guido Appenzeller and Nick McKeown, Stanford

5:15 - 5:30pm Wrap Up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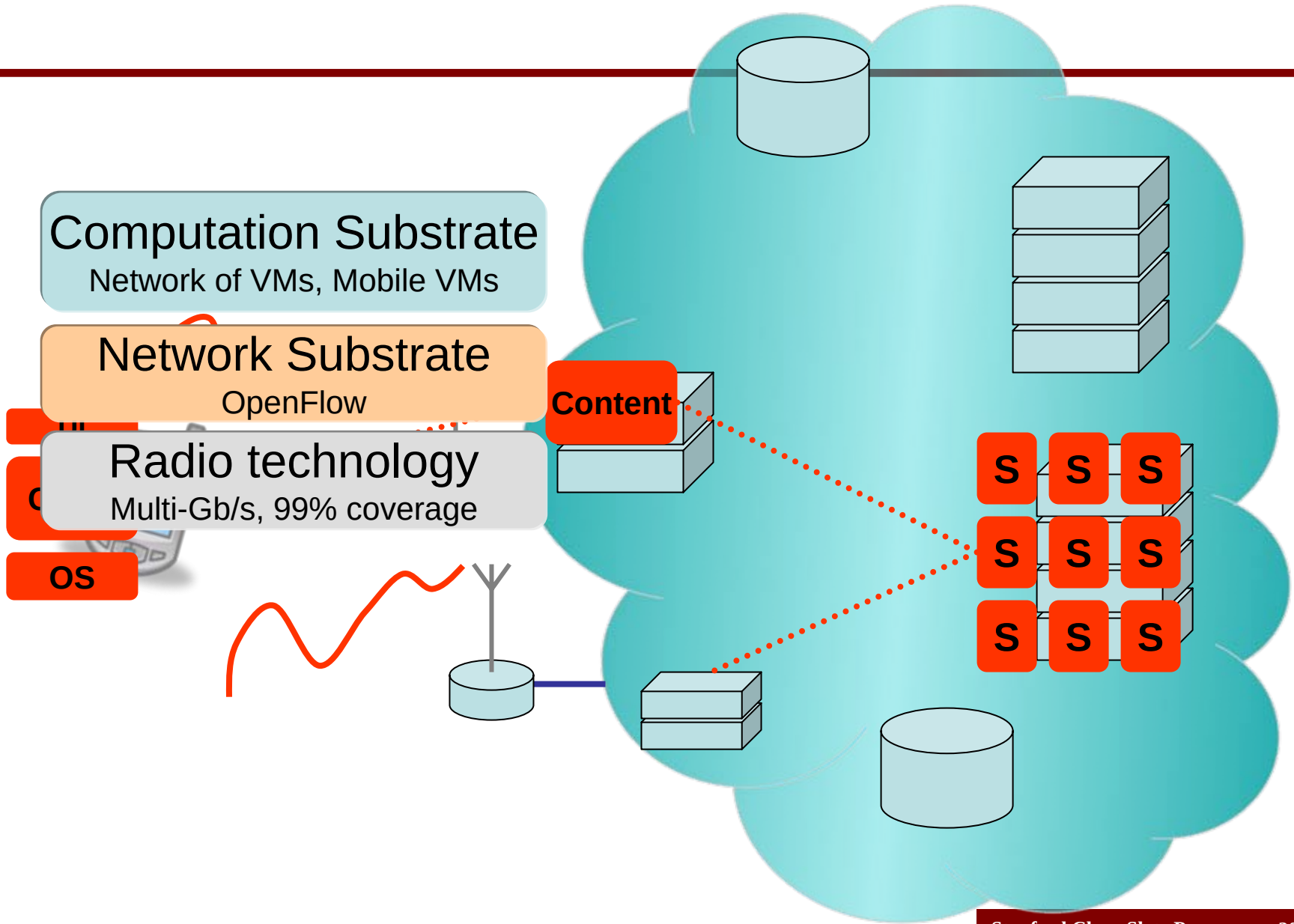
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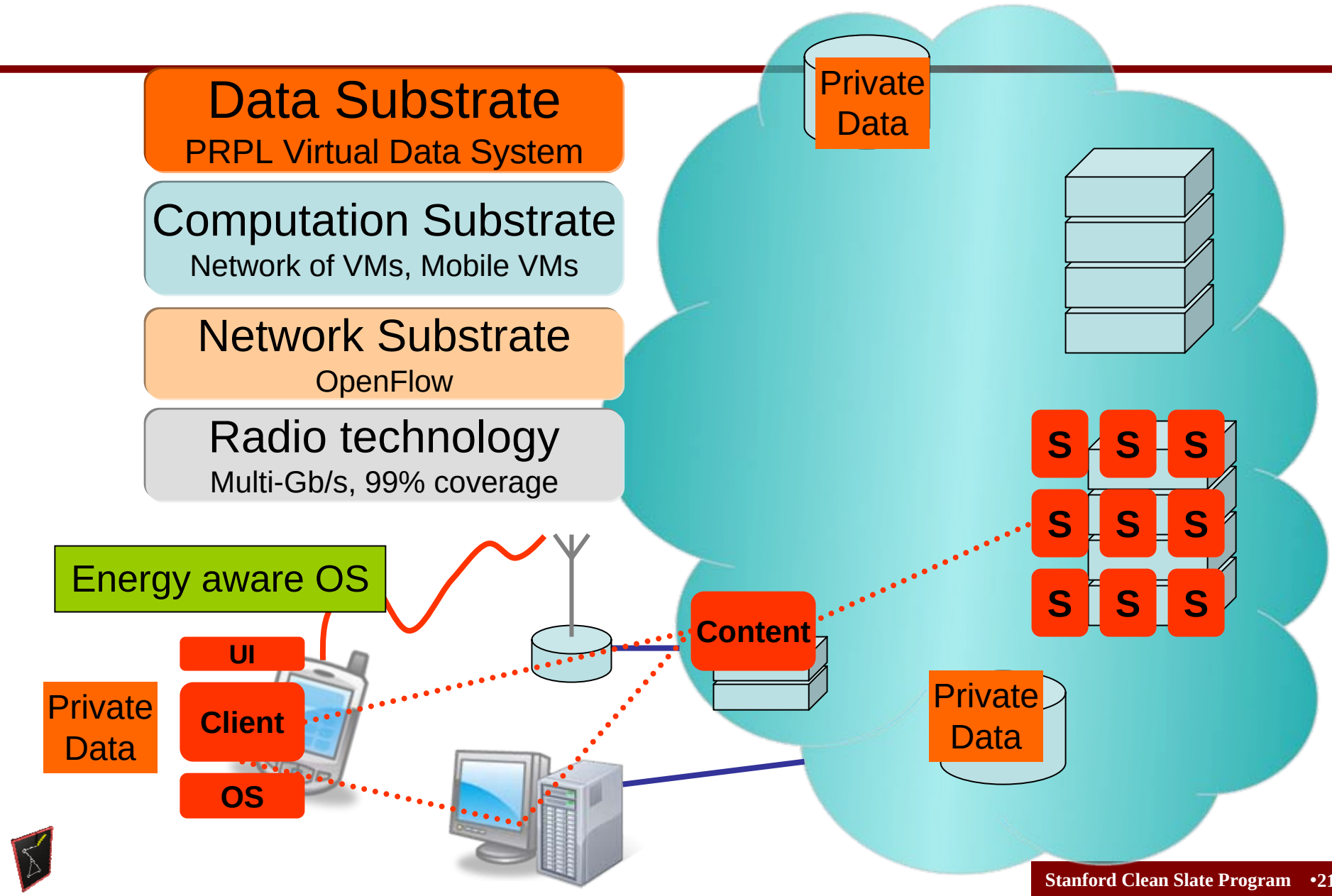
Data Substrate
PRPL Virtual Data System
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Network of VMs, Mobile VMs
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Private Data
S S S
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Energy aware OS
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