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Modern Telecommunications: Architectures versus Computation Models

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Three Ways For Resource Optimal Networking To Celebrate Diversity in Future Internet

- AICT2011 -

Panel: Modern Telecommunications

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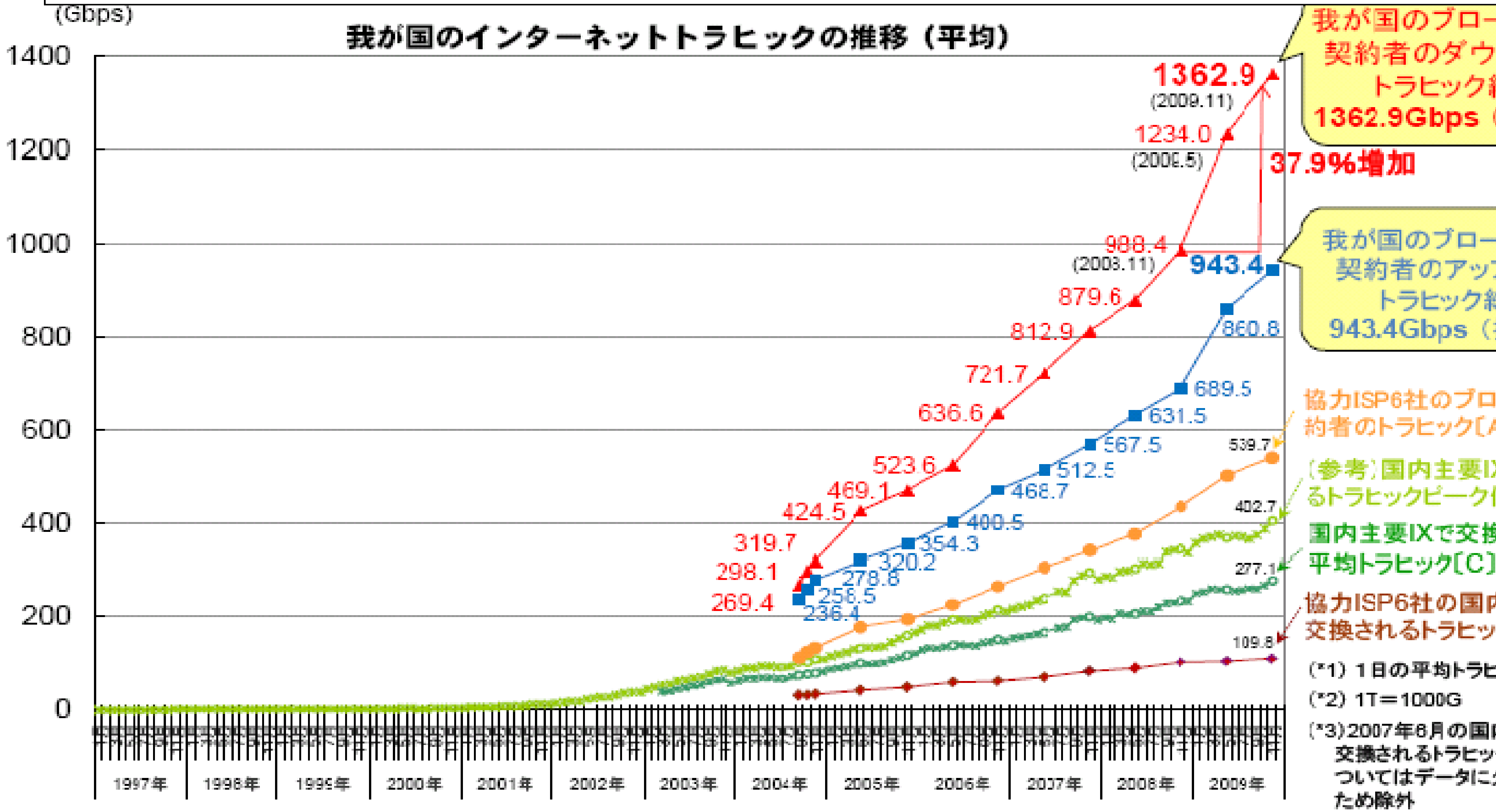
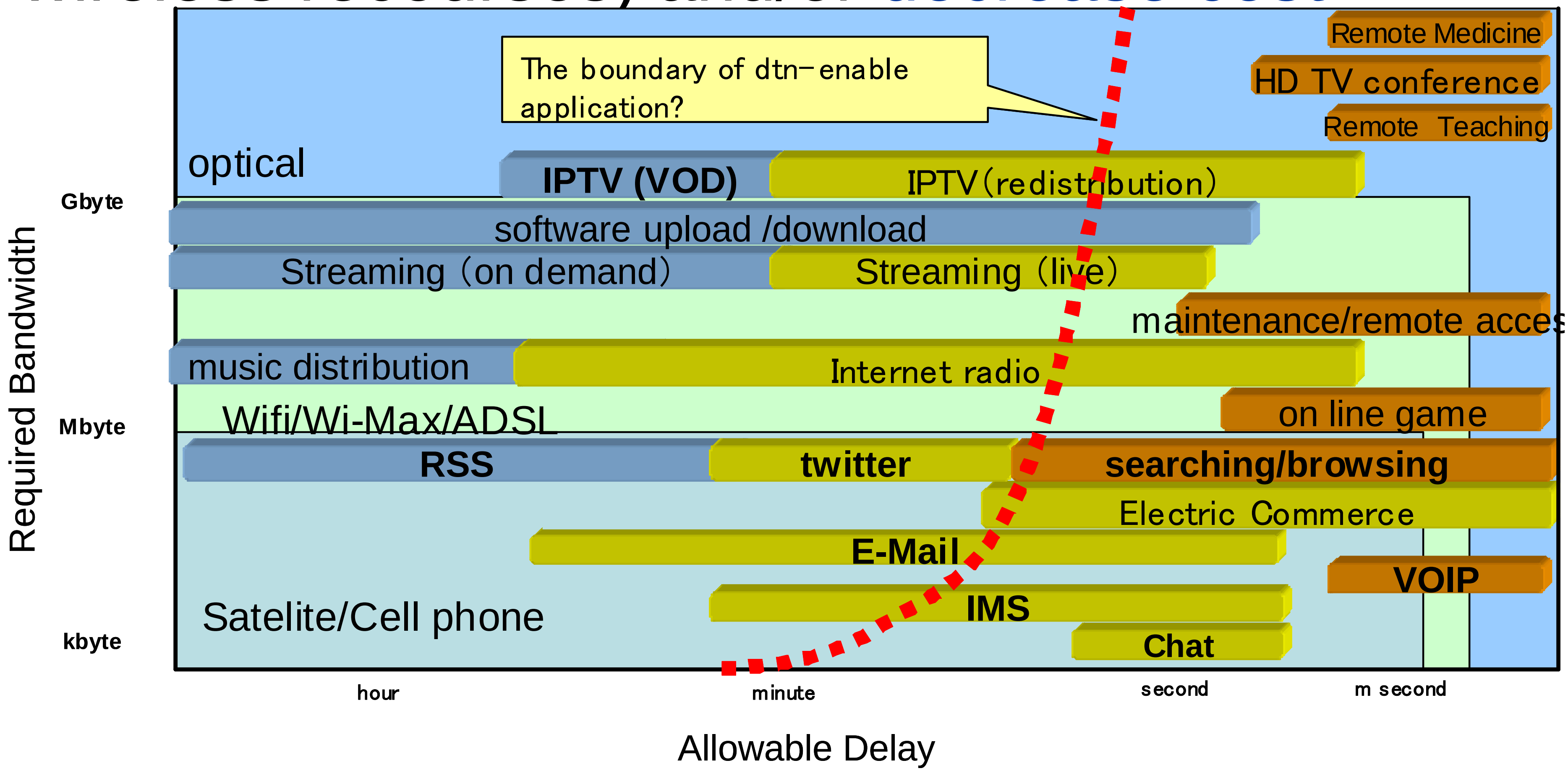
Internet Traffic: Still Growing

Downstream traffic by broadband-access subscribers in Japan: 1.36 Tbps. 2009 Nov. (From http://www.soumu.go.jp/menu_news/s-news/25387.html)



Network Application Diversity: Still Growing

- IF an application can be asynchronous and can tolerant some delay, **some techniques (e.g., DTN) can** increase efficiency (esp. for limited wireless recourses) and/or decrease cost



Two Issues in Future Internet

1. **Traffic growth** can NOT be coped with by Physical-Layer upgrade ONLY
   - e.g., Wireless/Optical tech. and infra.

+ Should be solved by **more efficient network resource allocations** globally and adaptively in **Upper-Layers**

2. **Diversity** can NOT be concealed by TCP/IP any more and makes inefficiency by mismatch

+ Should be revealed and celebrated for **more efficient network resource allocations**

Possible Solutions in Future Internet

For **more efficient network resource allocations**

(1) Spatial (among available hetero. networks -- **different capacity, coverage, connectivity**, ..)
- Multiple Network-Path Integration

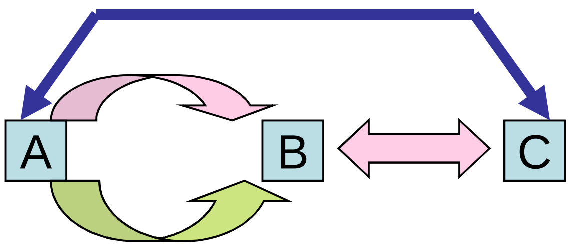
(2) Temporal (even **in long time-scale**)
- Store (&Carry)-Forward Networking

(3) Radio Frequency Domain (based on Spectrum Sensing **in space and time**)
- Cognitive Radio Networks

Not only Flexibility BUT **Scalability** is STILL required

Three Ways For Resource Optimal Networking

(1) Multiple Network-Path Integration



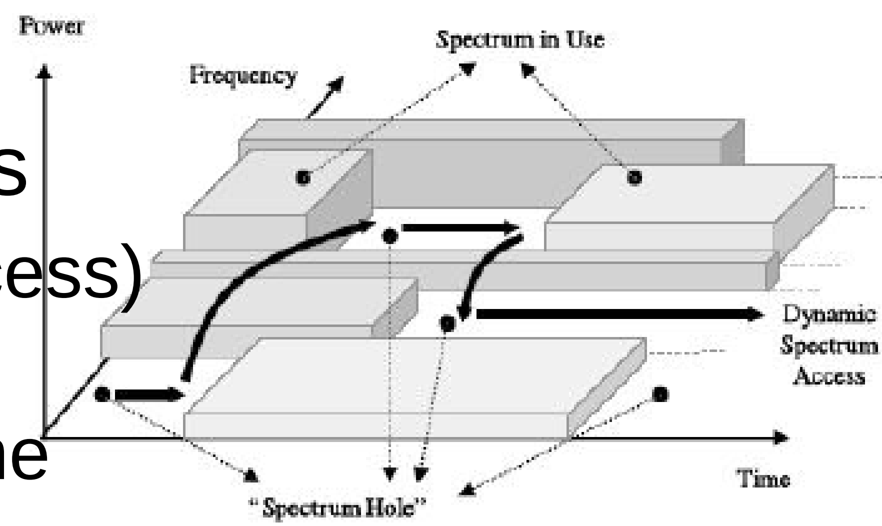
- INTEGRATION allows **using all network-paths** for a file transmission from A to C

(2) Store (&Carry)-Forward Networking

- STORE allows **waiting/choosing** best time and peer
- CARRY allows **conveying** data by physical movement instead of network media
- DTN in general sense

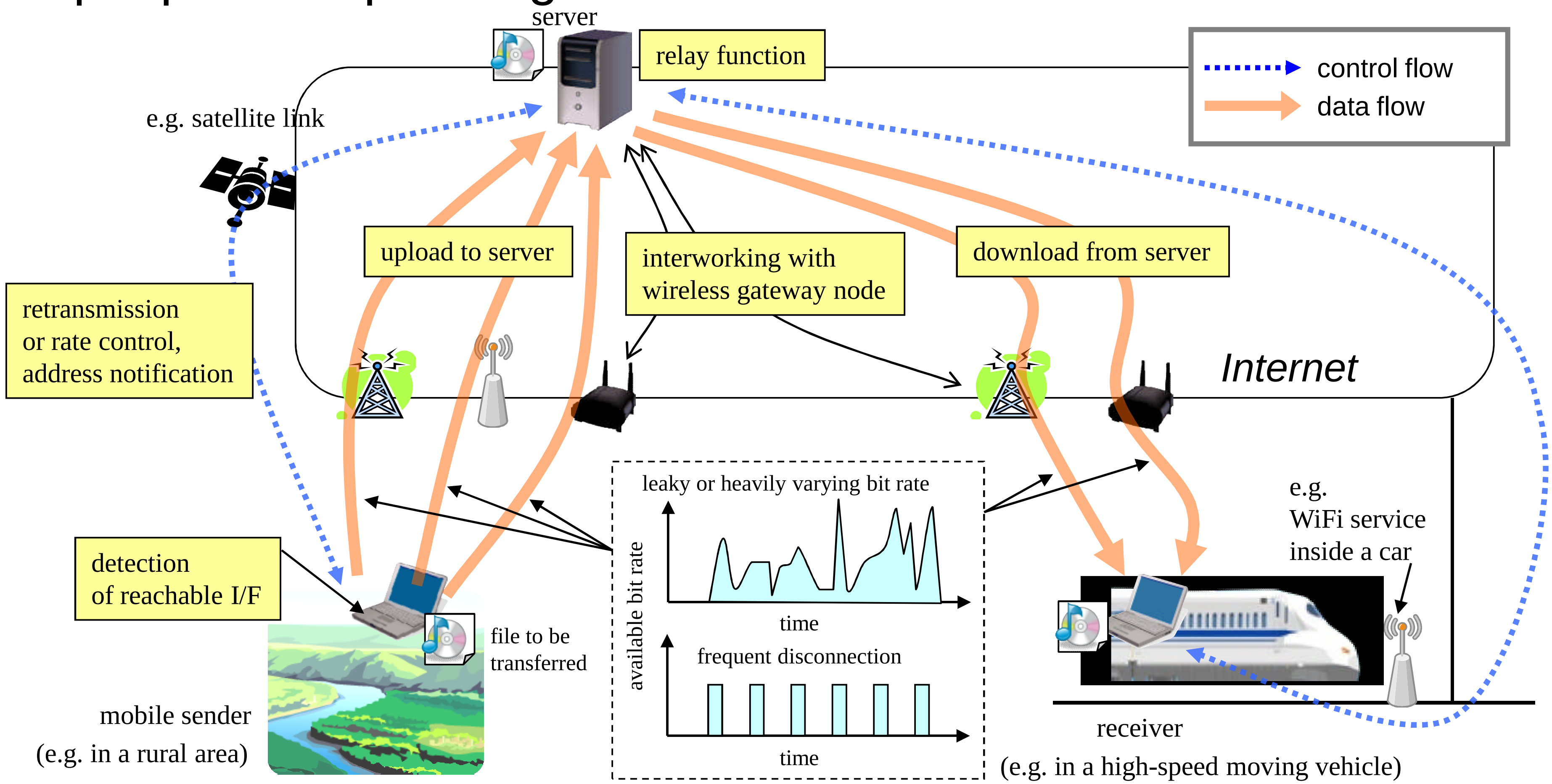
(3) Cognitive Radio Networks

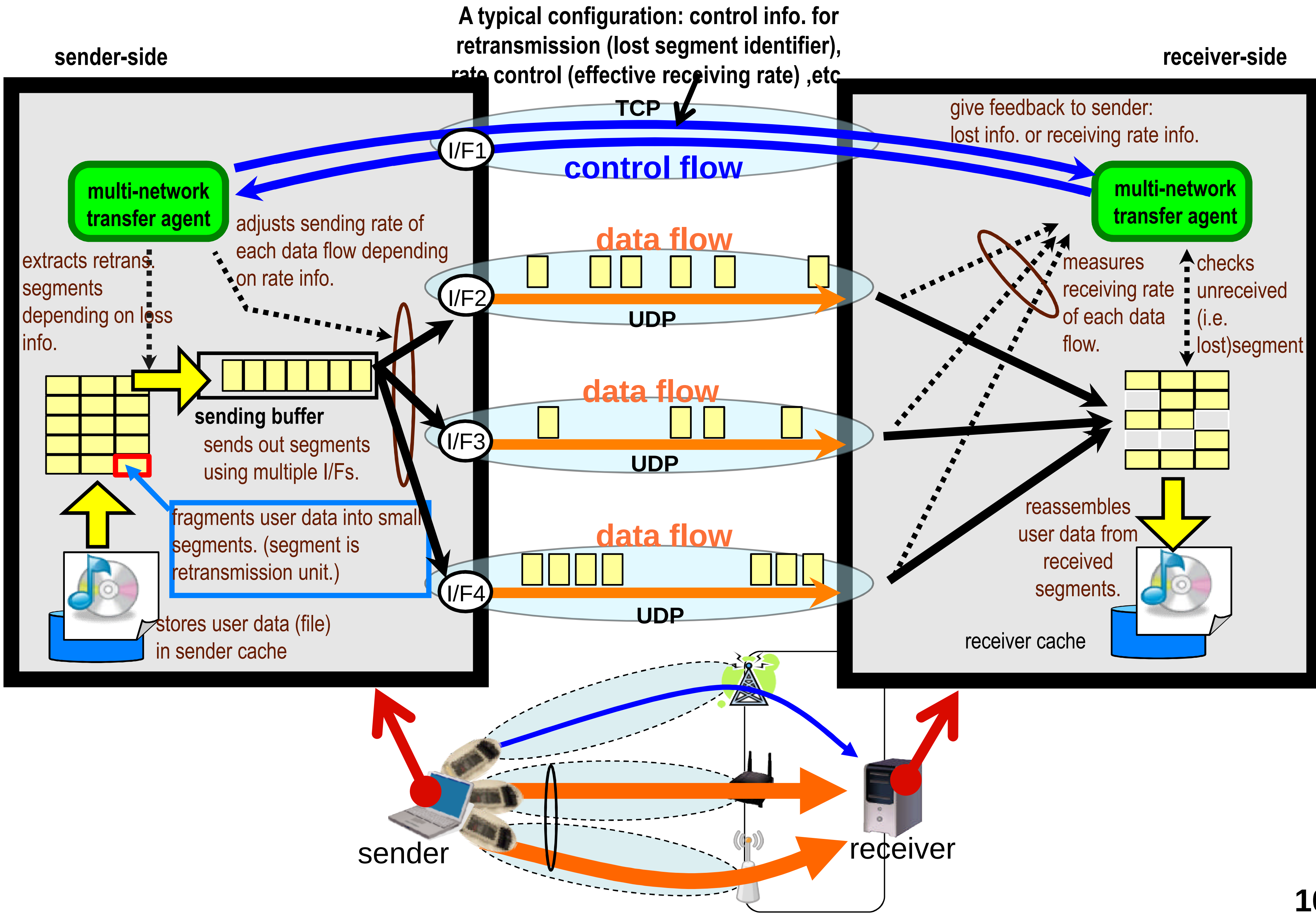
- DSA (dynamic spectrum access) allows **utilizing unused frequencies** in space and time



Integrated Multi-network Path Data Transfer

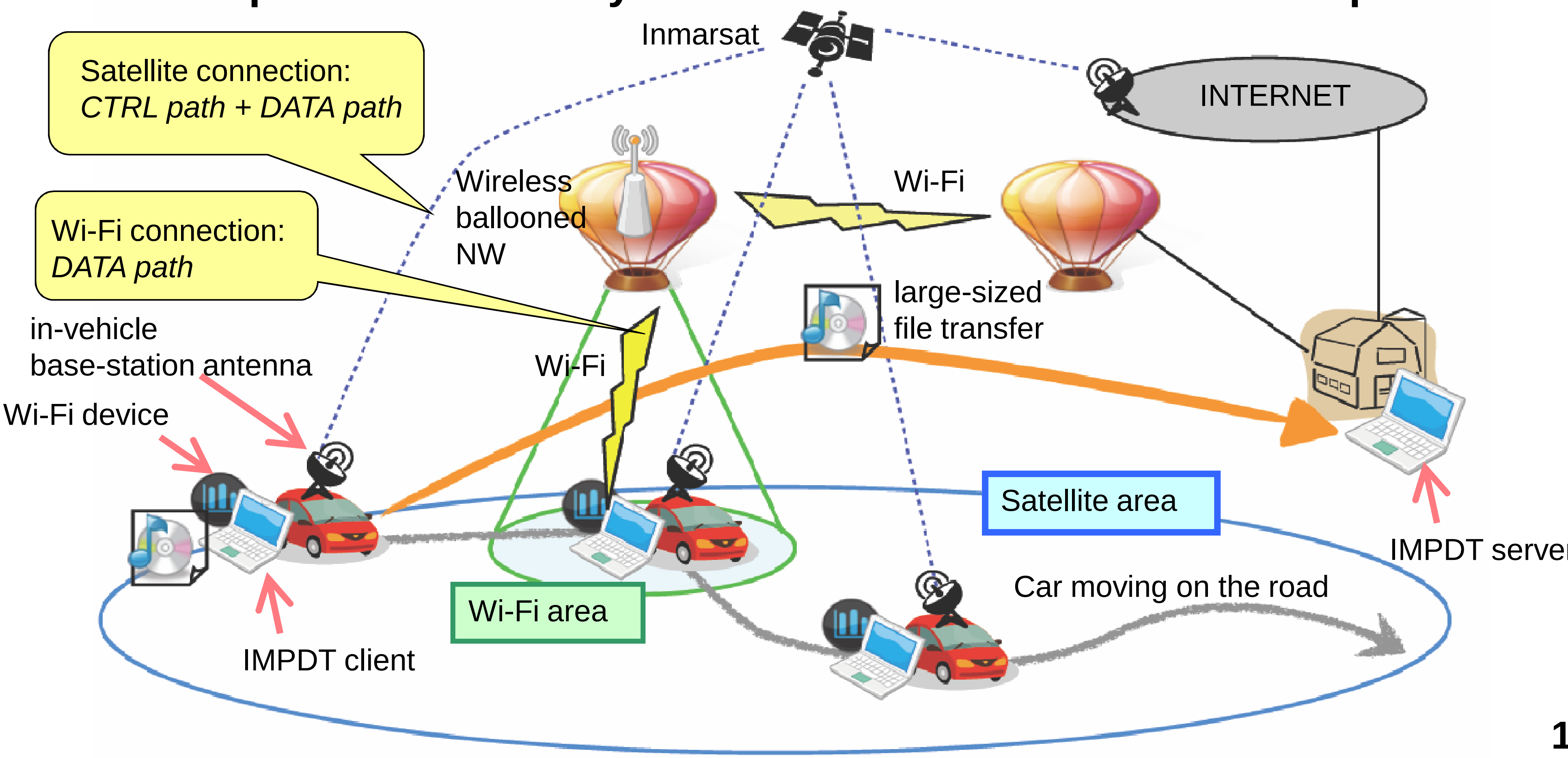
- Integrating wide-area, stable but low-speed NWs and narrow-area, high-speed but unstable NWs, if no single sufficient NW path available
- Not a simple bandwidth-aggregation; a transport protocol over multiple paths separating data flows and control flows



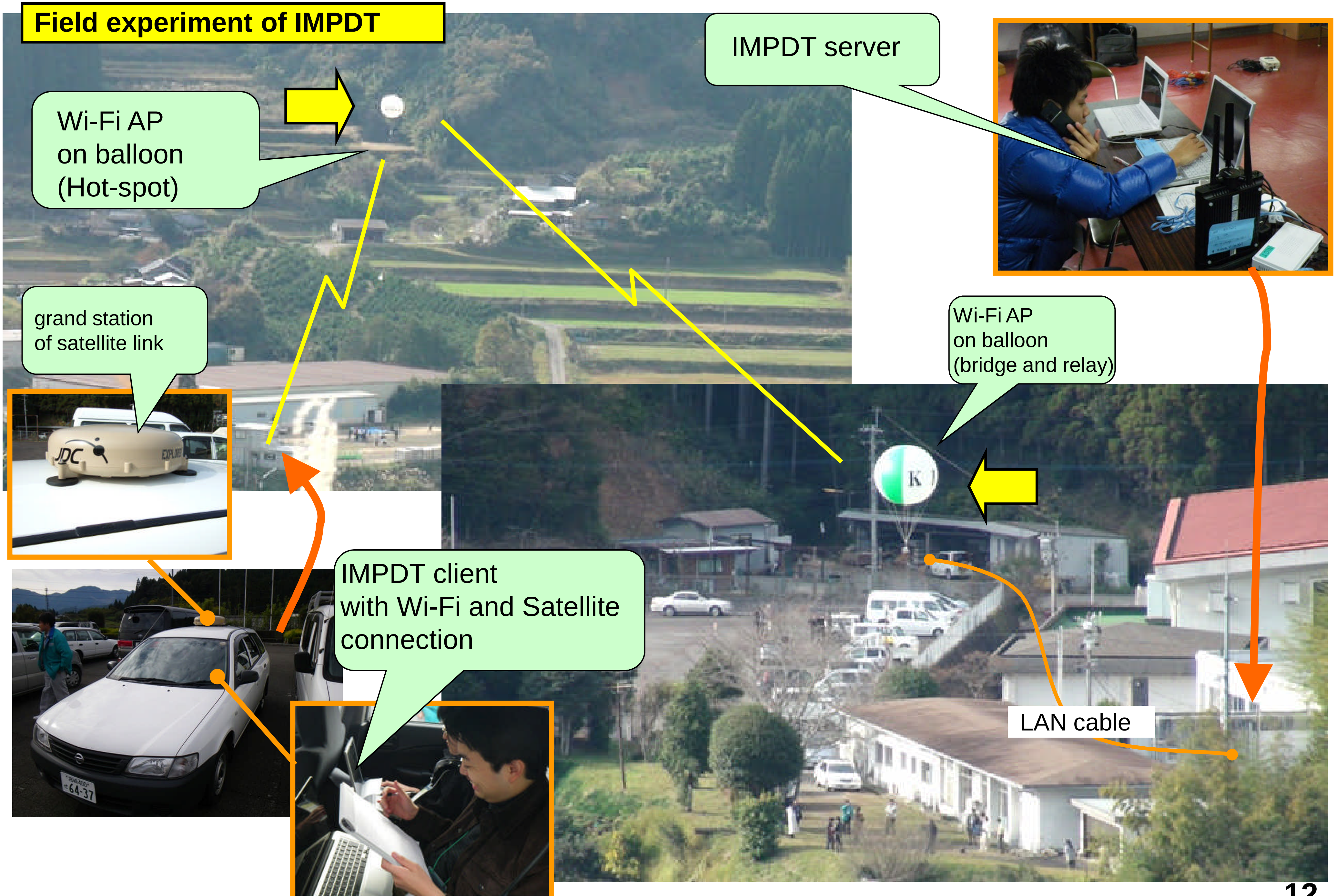

A typical configuration: control info. for retransmission (lost segment identifier), rate control (effective receiving rate) ,etc
sender-side
receiver-side
TCP
I/F1
control flow
give feedback to sender: lost info. or receiving rate info.
multi-network transfer agent
multi-network transfer agent
adjusts sending rate of each data flow depending on rate info.
extracts retrans. segments depending on loss info.
data flow
I/F2
UDP
measures receiving rate of each data flow.
checks unreceived (i.e. lost)segment
sending buffer
sends out segments using multiple I/Fs.
data flow
I/F3
UDP
fragments user data into small segments. (segment is retransmission unit.)
data flow
I/F4
UDP
reassembles user data from received segments.
stores user data (file) in sender cache
receiver cache
sender
receiver

Field Experiment using IMPDT proto-type system

- **An Emergency/disaster information networking (Nov. 2009)**
- **A large data is transmitted from a car to the headquarter**
- **Network paths integrated :**
  - **Satellite link -> slow-but-stable control path**
  - **Multi-hop Wi-Fi network by balloons -> fast-but-unstable data path**

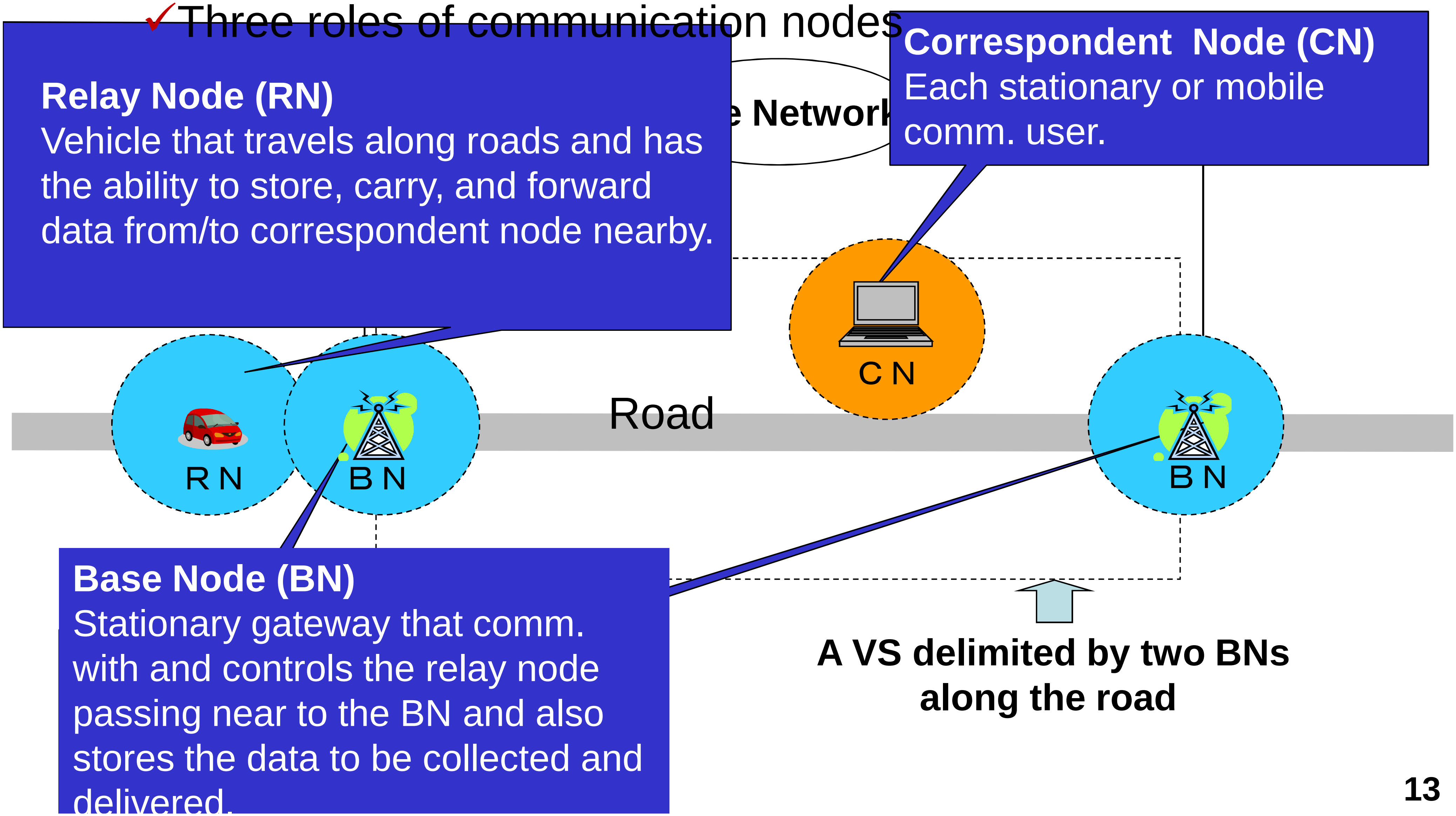


Field experiment of IMPDT



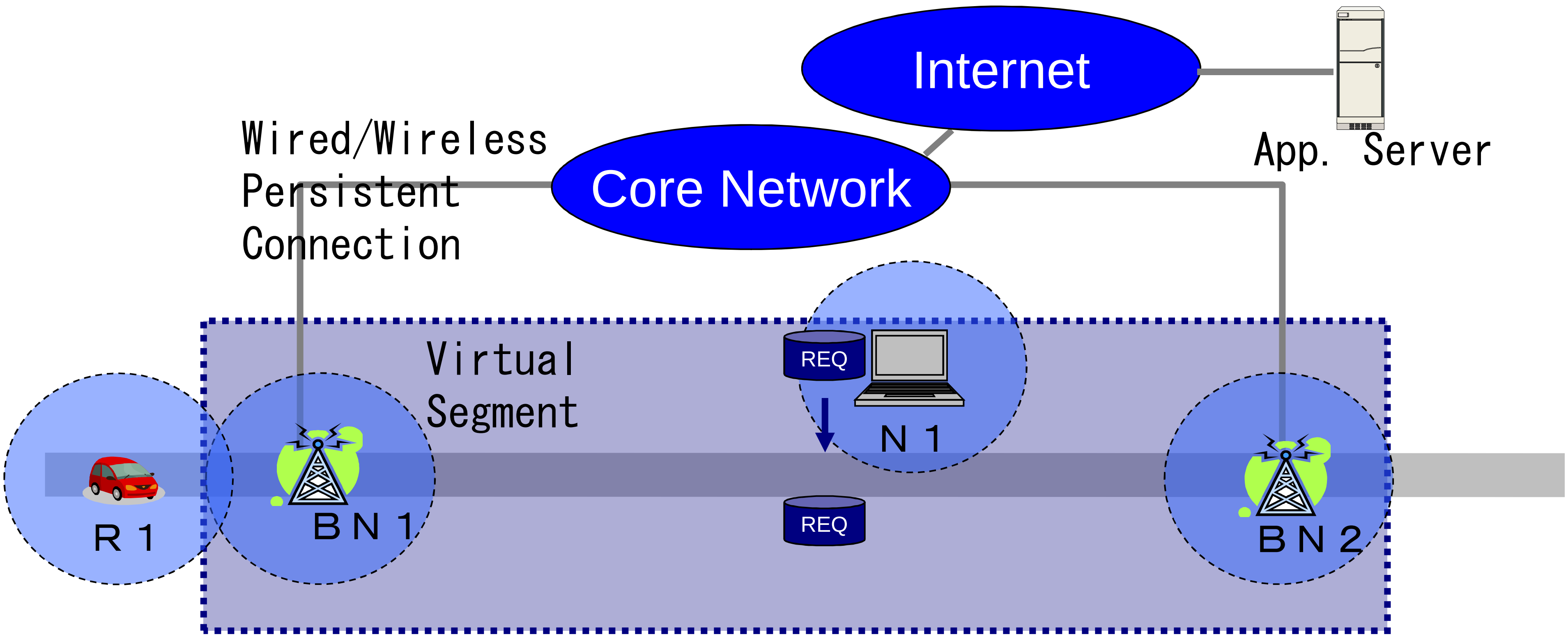
Virtual Segment - VS

- ✓A store-carry-forward based access network infrastructure along roads to support asynchronous large data exchange
- ✓Three roles of communication nodes



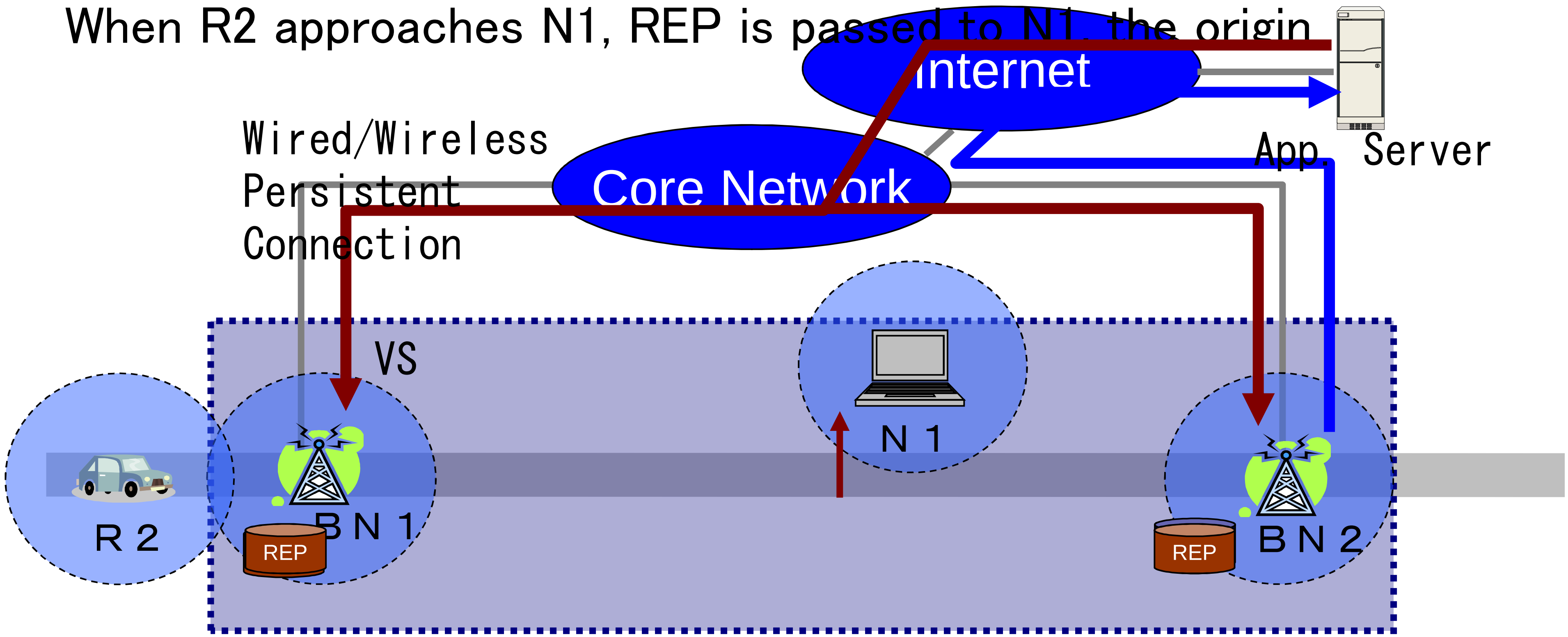
Message exchange between VS and Internet

1. User N1 wants to send a request message (REQ) to Internet
2. Car R1 crossing BaseNode BN1 acts as a relay in this VS
3. When R1 approaches N1, REQ is passed to N1
4. When R1 approaches BaseNode BN2, REQ is passed to BN2



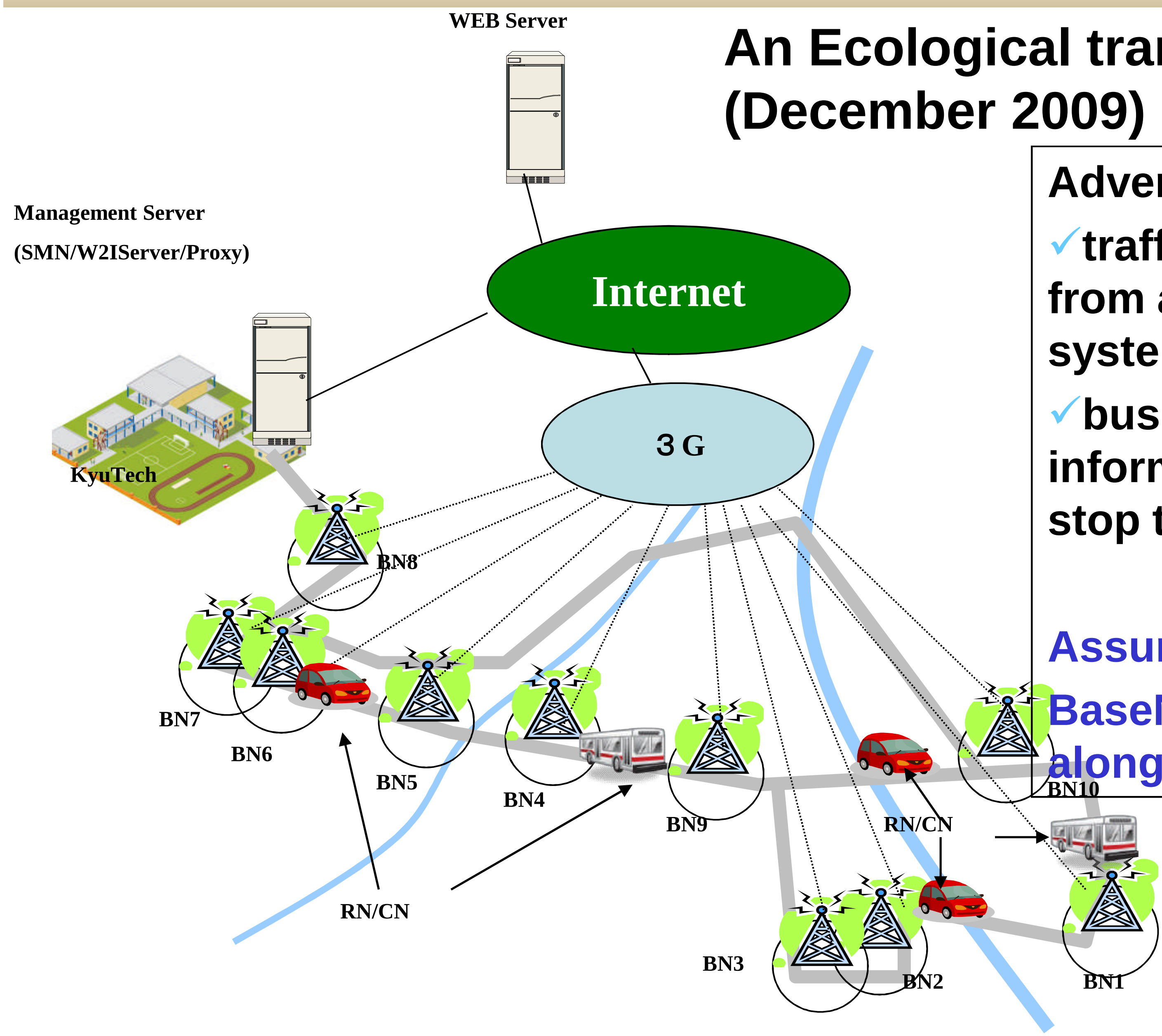
Message exchange between VS and Internet (cont.)

5. BaseNode BN2 sends REQ to the destination (the application server) on the Internet though a core network
6. A reply message (REP) is sent to both BN1 and BN2
7. When R2 approaches BN1, REP is passed to R2
8. When R2 approaches N1, REP is passed to N1, the origin



Field Experiment using VS proto-type system

An Ecological transportation system (December 2009)

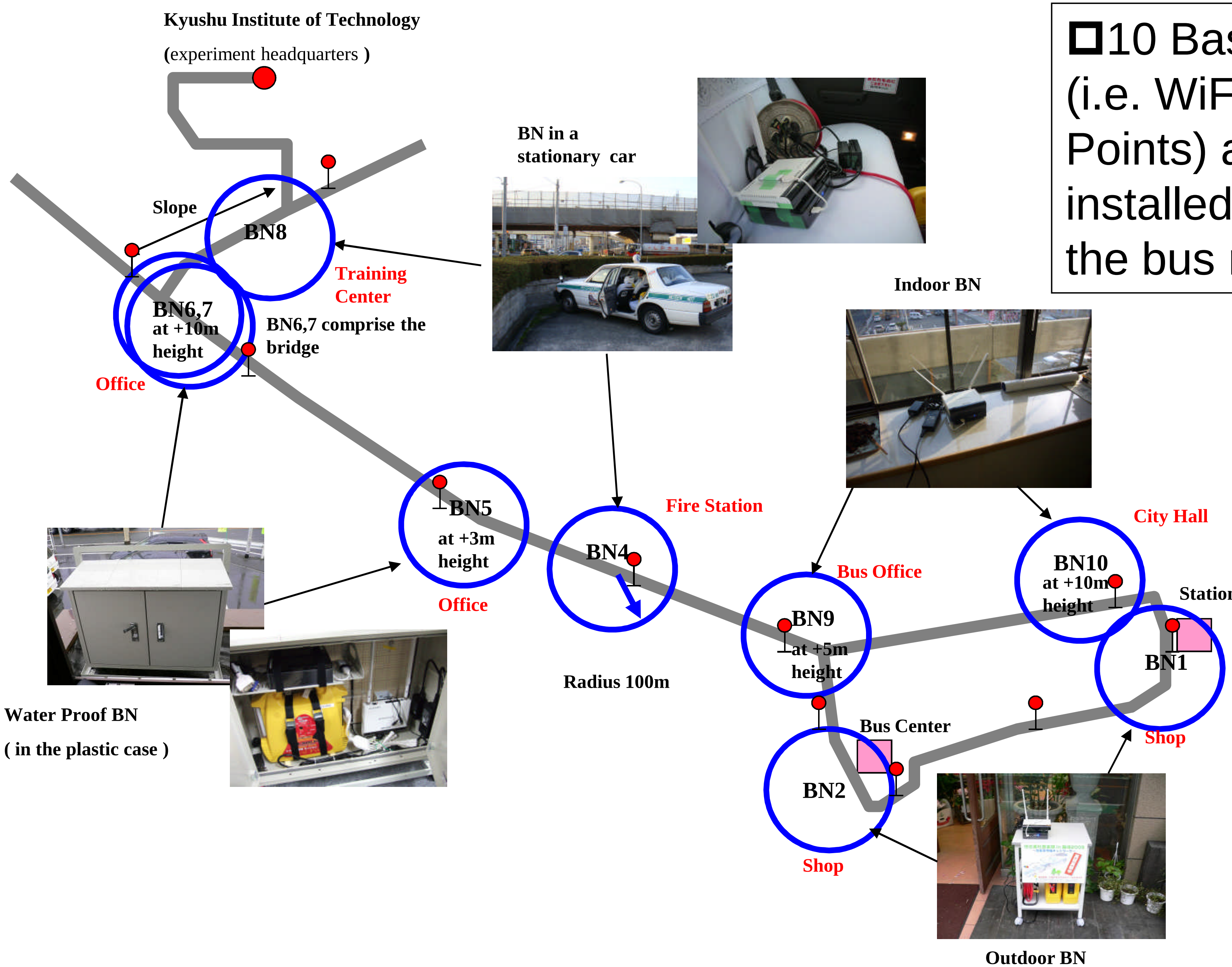


Advertizing

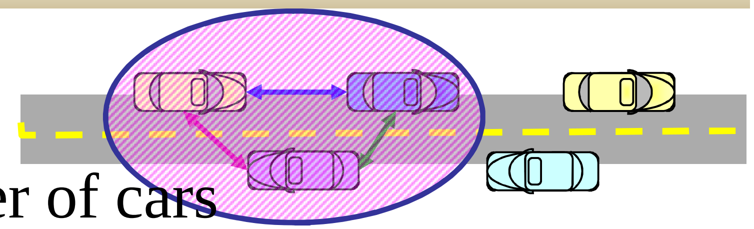
- ✓traffic congestion info. from a bus to the navigation system in each car
- ✓bus seat occupation information to users at a bus stop through web

Assuming ITS deployment, BaseNodes can be available along the road in future

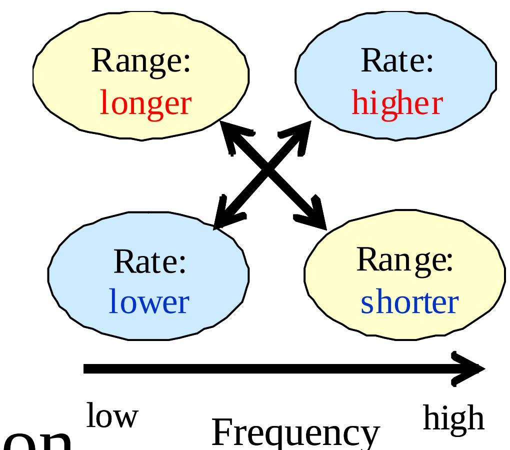
□10 BaseNodes (i.e. WiFi Access Points) are installed along the bus road



DSA in Vehicle-to-Vehicle (V2V) Communications



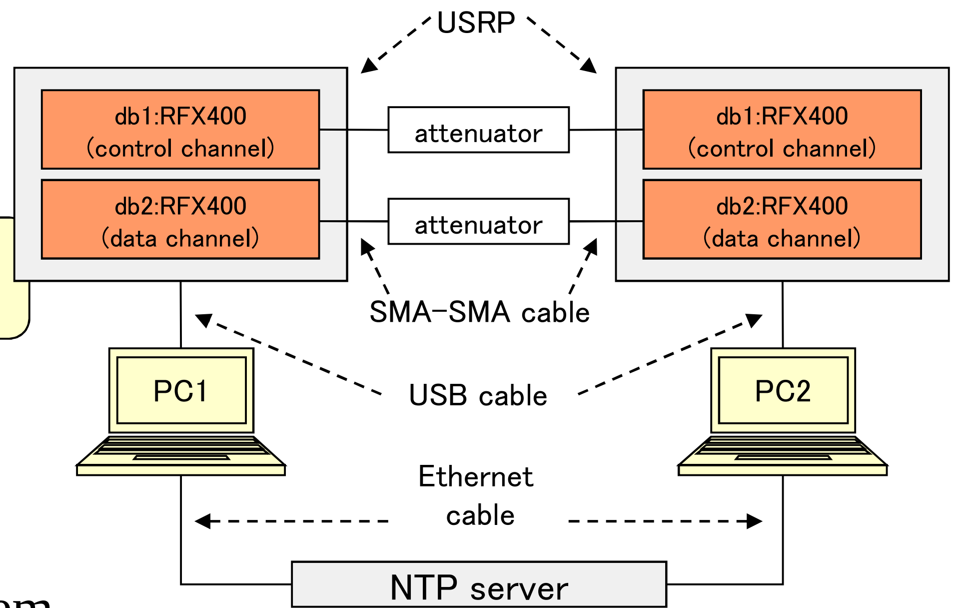
- Merits of DAS in V2V
  - Using unused frequencies for a large number of cars
  - Choosing a better channel for each diverse V2V application
  - Within a broad range of available frequencies
- Difficulties in **Upper-Layers**
  - No infra, No master, Change of topologies
  - Change of unused frequencies due to area change



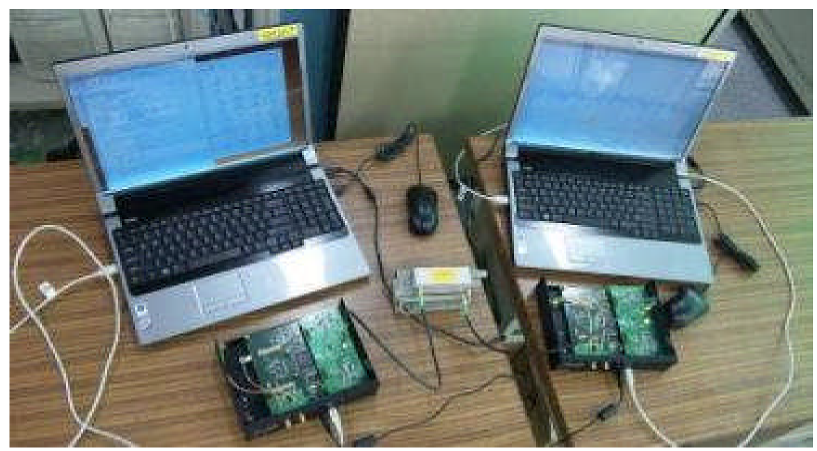
⇨ Decentralized dynamic channel/route coordination
  - Control channel coordination among cars
    - Using space and time information obtained from GPS
  - App-aware Data channel coordination and Route construction
    - Using information exchanged by Control channels
    - A sort of Multiple Network-Path Integration

Preliminary Experiments using GNURadio+USRP

- A USRP have **only two** daughterboards
  - Two experiments
    1. Control channel + spectrum sensing
    => Evaluation of sensing capability
    2. Control channel + Data channel
    => Evaluation of communication capability
- SMA-SMA cable (coaxial cable)
  - is used to emulate the wireless link between interfaces
- Two PCs are connected to a NTP server to achieve time synchronization between them
- Spec.
  - GNU Radio 3.2
  - PC : Dell Studio 1737 Laptop
    - CPU:Intel Core 2 Duo T9600 2.80GHz
    - RAM:3GB
    - OS : Ubuntu 9.04
- Note: Combined with real GPS device and working on USRP2 NOW



System components



Conclusion

- What we focus on: Three Upper-Layer Ways For Resource Optimal Networking
  - Multiple Network-Path Integration
    - ✓ e.g., IMPDT (Integrated Multi-network Path Data Transfer)
  - Store (&Carry)-Forward Networking
    - ✓ e.g., VS (Virtual Segment)
  - Cognitive Radio Networks
    - ✓ e.g., DSA in V2V communications
- What needed next for Future Internet
  - A **Unified NW Architecture** allowing the three ways coexist and cooperate with each other **with scalability**
  - An **Interface Model to Applications/Users** allowing ...

Examples of Future Internet Architecture

FIA (Future Internet Architecture): Press Release 10-156: NSF Announces Future Internet Architecture Awards, http://www.nsf.gov/news/news_summ.jsp?cntn_id=117611&org=OLPA **(Sep 2009)**

- Named Data Networking
  - Principle Investigator: Lixia Zhang, UCLA
  - The proposed Named Data Networking (NDN) architecture moves the communication paradigm from today's focus on "where", i.e., addresses, servers, and hosts, to "what", i.e., the content that users and applications care about.
- MobilityFirst >> can exploit time-domain optimization
  - Principle Investigator: Dipankar Raychaudhuri, Rutgers University
  - The architecture uses generalized delay-tolerant networking (GDTN) to provide robustness even in presence of link/network disconnections.
- NEBULA
  - Principle Investigator: Jonathan Smith, University of Pennsylvania
  - The project focuses on developing new trustworthy data, control and core networking approaches to support the emerging cloud computing model of always-available network services.
- eXpressive Internet Architecture
  - Principle Investigator: Peter Steenkiste, Carnegie Mellon University
  - XIA addresses these needs by exploring the technical challenges in creating a single network that offers inherent support for communication between current communicating principals--including hosts, content, and services--while accommodating unknown future entities. For each type of principal, XIA defines a narrow waist that dictates the application programming interface (API) for communication and the network communication mechanisms.

Modern Telecommunications: Architectures versus Computation Models (Pannel Discussion)

Tony McGregor

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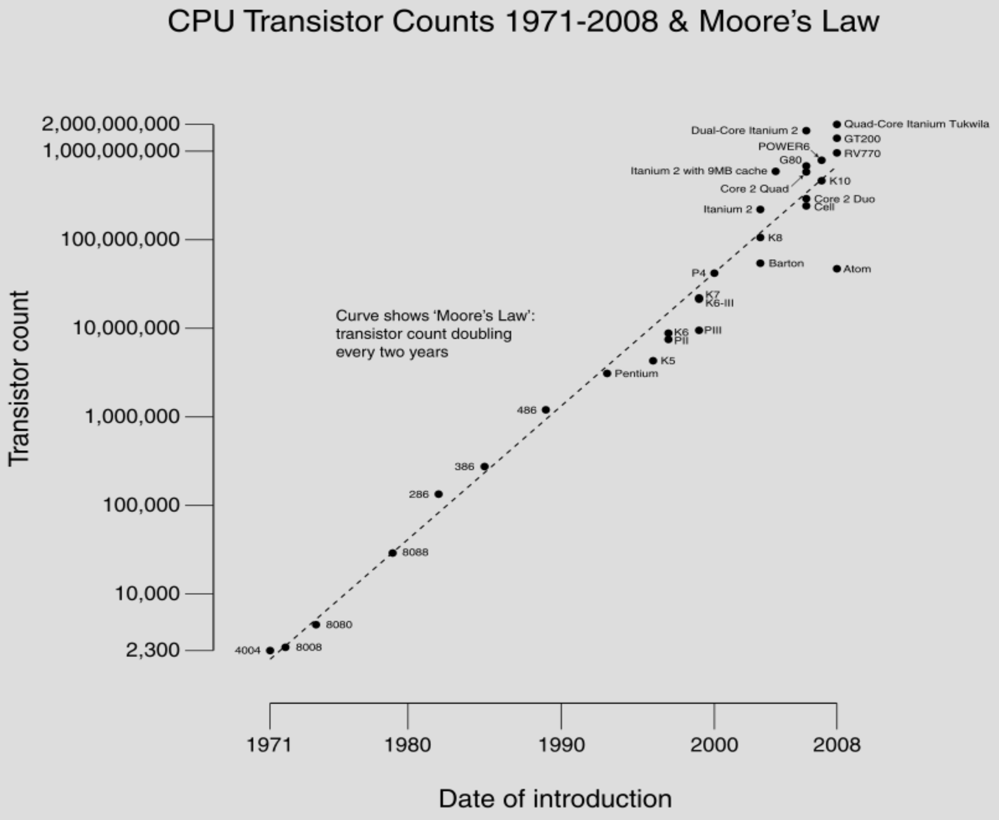


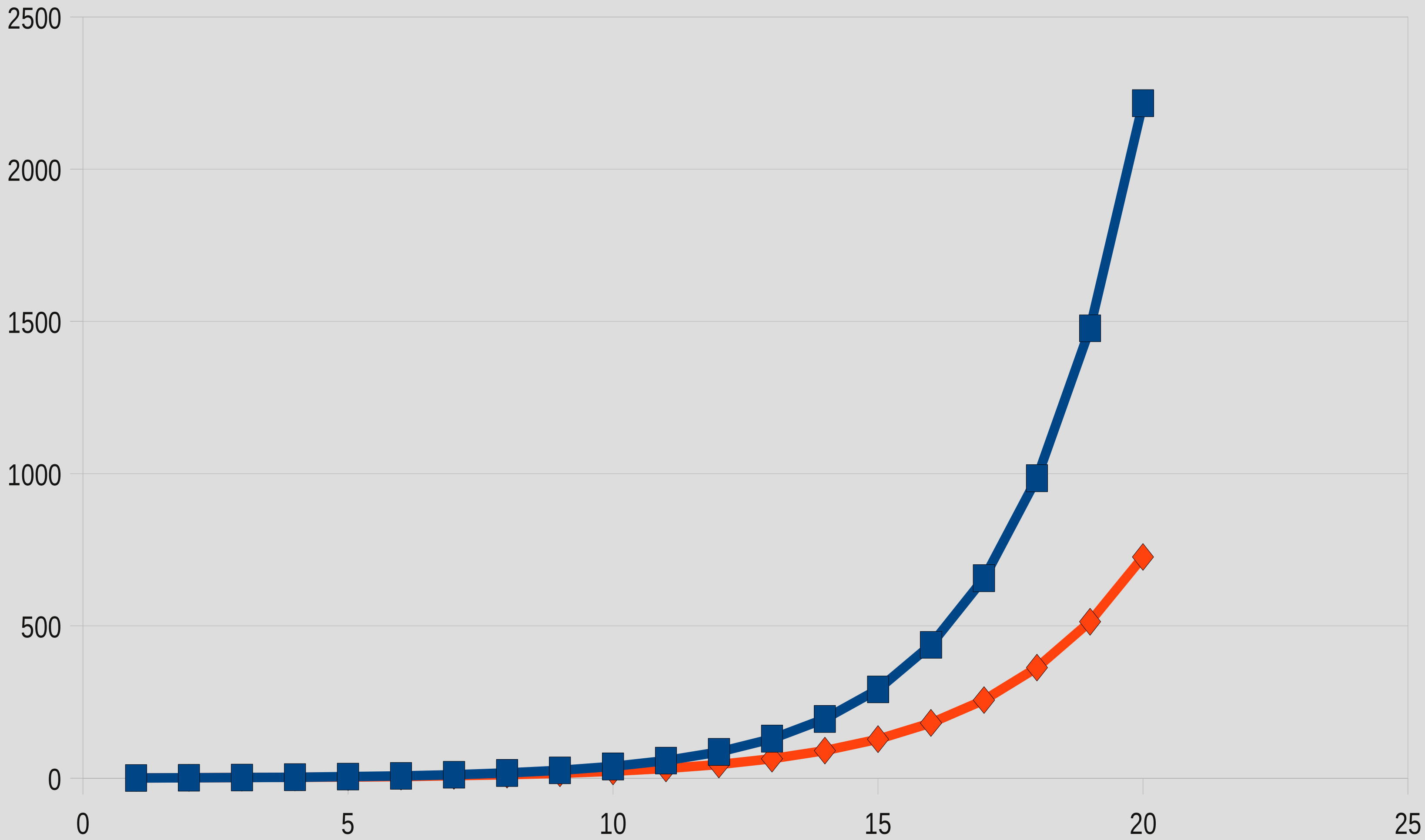
What I learned at University

- *“In a few years time we won't have hard drives. RAM is getting so much cheaper, we won't need them.” --lecturer circa 1979*
  - Relationships are more important than Moore
- *Unix is technically superior to MSDOS and will soon superseded it.*
  - *Momentum rules: Transition*

Relationships Are More Important that Moore

- We all know (an approximation of) Moore's law
  - It tells us a lot but less than we expect
  - The time we spend doing a particular task on a computer (e.g. writing a document, updating student records, copying a large file, printing a document) hasn't changed much.
    - But we do a better (more technically sophisticated) job.
  - We need to look more to the relationships between things
  - e.g. between Moore's Law and Nielsen's Law

Relationships Are More Important that Moore



Momentum Rules

- He who's first, wins.
  - Or at least has a really good head start
  - Transition is really, really hard

  - Windows vs the rest
  - TCP/IP vs OSI
  - IPv4 vs IPv6
  - POTS vs public VoIP
  - Old Telco vs New Entrant

Interrupting the structural architecture of education

Lorayne Robertson, UOIT   March,2011

How is educational technology implementation like viewing bumper cars? …

- Bumping around in the dark for short rides, not very organized, not a lot of progress evident, going around in circles, often lots of fun, not much learning happening, some bumps along the way but bumping softly enough that you are eager to try it again…
- Evidence of an awareness that there are likely better ways to go about this…

Current Structural Enigmas or "Things that bump up against each other"

1. Standardization vs. real-time learning
2. *Leaping tadpoles and stationary frogs*
3. Transmission instead of Transformation
4. *For profit rather than open source*
5. Performance vs. failures as fertilizer
6. *Focus on systems or focus on people*
7. Both the "technical stuff" and the "ethos stuff"

Educational technology: a new paradigm

1. Web architecture with the privacy and security requisite for vulnerable populations
2. A focus on learning rather than instruction
3. Pedagogy that is constructivist and critical
4. Continued inquiry on technology affordances
5. Knowledge mobilization (sharing, translation)
6. Online, professional communities of practice
7. Structural: Student-focused, just-in-time learning paths