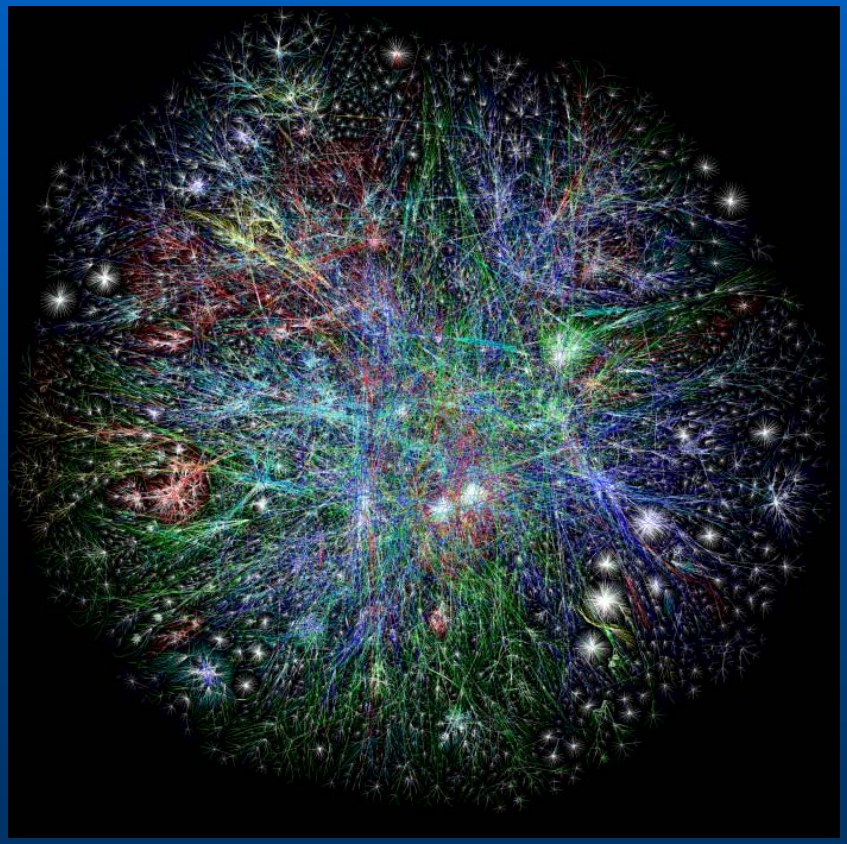
PLANETE

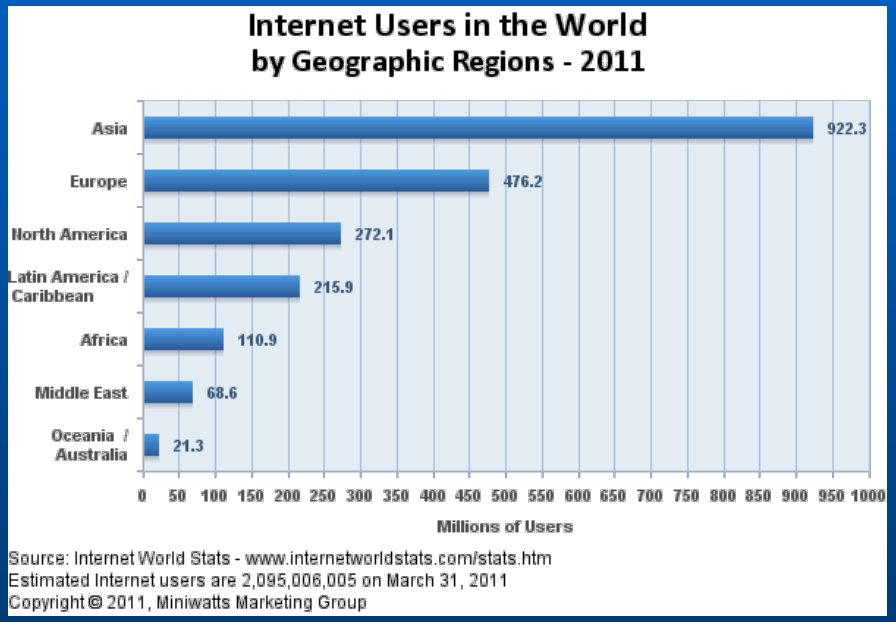
Protocols and Applications for the Internet

Walid Dabbous

http://planete.inria.fr

Today we have the Internet





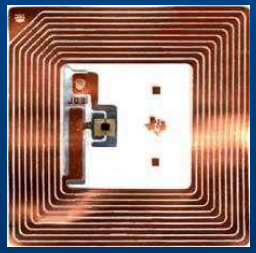
Estimated to 2,095,006,005

7 billion persons

December 2011

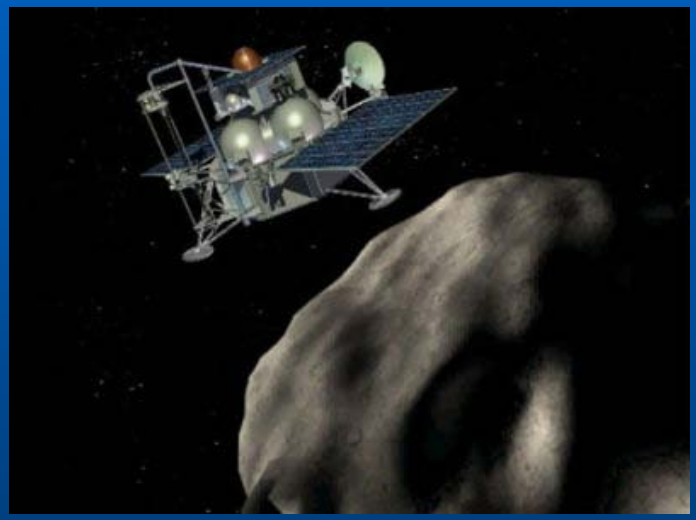
Internet Evolution

- Increasing heterogeneity



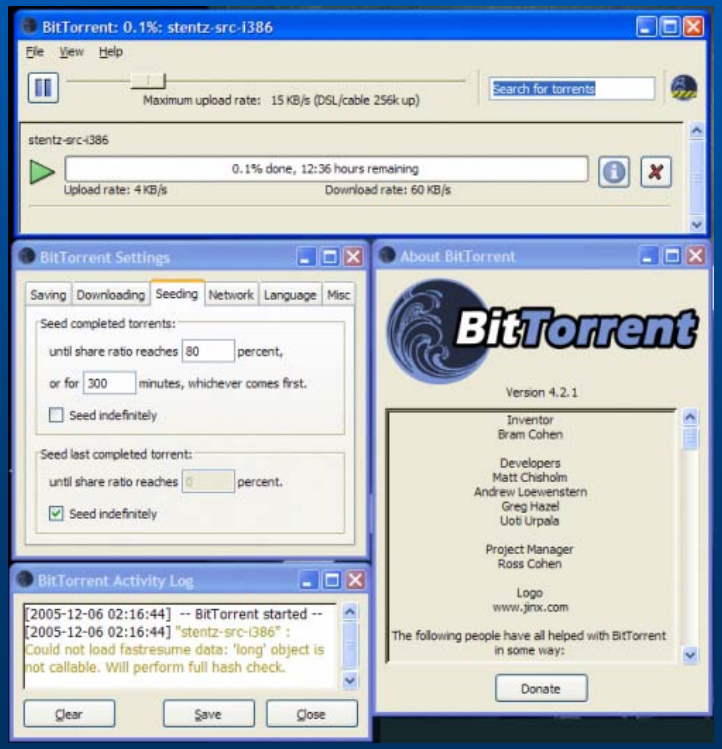
Internet Evolution

- Mobility and episodic connectivity



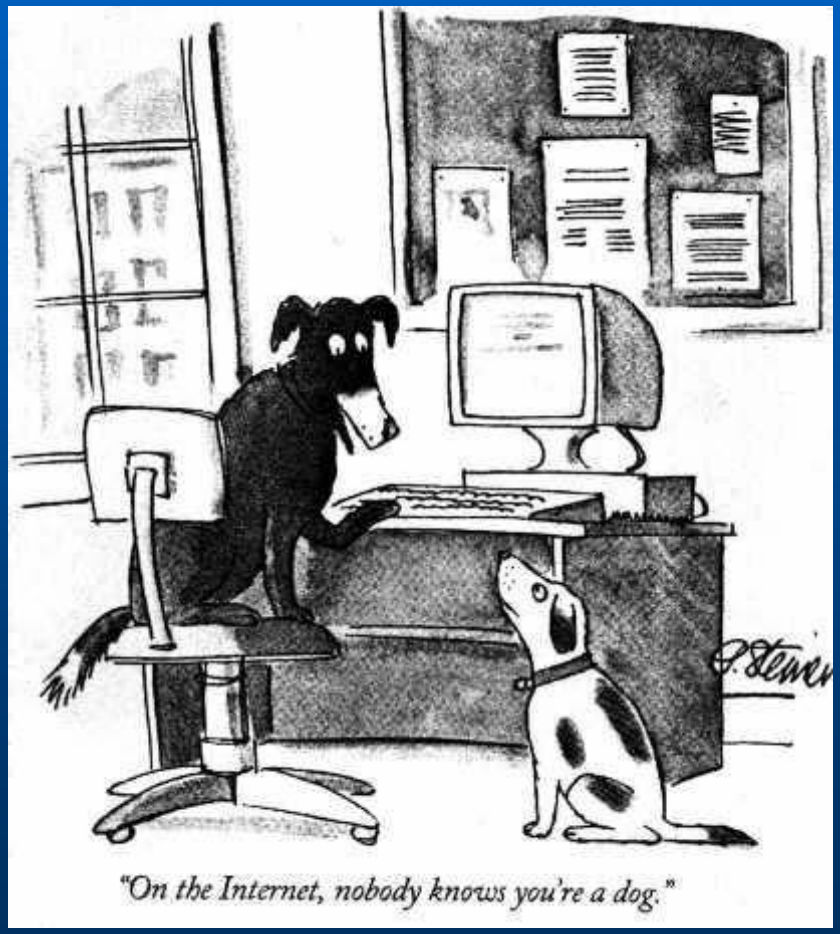
Internet Evolution

- Unusual but legitimate traffic load
- Delivery of real-time high-bandwidth video services



Internet Evolution

- “Stakeholders” with no mutual trust



Incremental or Disruptive

Incremental patches

Clean Slate approach

- "Network Innovations" may follow either of these two approaches
- Validation
  - Overlays
  - Large scale experimental platforms

The team

INRIA researchers

Walid dabbous (S), Claude Castelluccia (G),

Thierry Turletti (S), Vincent Roca (G),

Chadi Barakat (S), Arnaud Legout (S),

Mohamed Ali Kaafar (G).

Permanent Engineers

Thierry Parmentelat (S).

9 Research Engineers

15 PhD students

Planète Research Directions

1. Efficient Data Dissemination
   - Content centric Networking
2. Network security
3. Network monitoring
4. Evaluation platforms and methodology

- With an experimental approach

1. Efficient Data Dissemination

- Design of efficient, robust and secure broadcasting systems
- Peer-to-peer architectures
- Cope with episodic connectivity
- Content sharing in ad-hoc networks

Data Broadcast

- Application-Level FEC Codes and their applications to broadcast/multicast systems
- A new File delivery application for content distribution
- Enhanced MAC level Encoding scheme for Mobile Satellite TV Broadcasting

AL-FEC

- research opportunities
  - numerous interesting future R&D directions:
    - low rate codes, “Gaussian elimination friendly” LDPC codes, low working memory decoding, UEP, interactions with source video coding, redundancy optimal location in a TCP/IP stack
  - many opportunities to disseminate (IETF, open-source codecs, publications)
- Dissemination
  - **Our LDPC-Staircase codes have been included this year as the primary AL-FEC (Application Layer Forward Erasure Correction code) solution for ISDB-Tmm (Integrated Services Digital Broadcasting, Terrestrial Mobile Multimedia), a Japanese standard for digital television (DTV) and digital radio.**

Building blocks for content distribution

- research activities
  - new file-casting application (we have a much better FLUTE replacement, *FCAST*)
  - contributions to and evaluation of *FECFRAME streaming architecture*, and more generally FEC based robust streaming systems
- on-going projects
  - now: *PhD with ALU-BL* on “robust, self adaptive, video streaming in wireless systems”

Mid-way between AL-FEC and content distribution systems in fact!

Peer-to-peer protocols

- Focus on BitTorrent
  - Large scale experiments
  - Large scale measurements
- Properties of the core algorithms of BitTorrent
  - We show there are close to optimality
- Properties of the overlay construction strategies
  - We show some pathological behaviors

Peer-to-peer protocols

- BitTorrent Locality
  - We show that we can push BitTorrent locality much further that previously known and that it saves 40% of inter-ISP traffic at the scale of the Internet
- BitTorrent Piracy
  - We characterize the impact of piracy
- Skype Privacy Issues

Episodic Connectivity

- Goal: Manage transparently the mobility of users in a heterogeneous network with episodic connectivity

- Points to resolve:
  - Service continuity between infrastructure, ad hoc and DTN networks
  - Reliable and secure communications
  - Design adequate congestion control mechanisms

Episodic Connectivity

- First results:
  - Protocole MeDeHa : Support of service discontinuity between infrastructure WiFi and ad-hoc networks
  - Heuristics to enhance routing in DTN
- Objective:
  - Adaptive routing mechanism for infrastructure, MANET and DTN networks
  - Tested in INRIA and UCSC testbeds
- Collaborations:
  - Associated team COMMUNITY avec UCSC
  - ETH Zurich

Content sharing in wireless ad-hoc networks

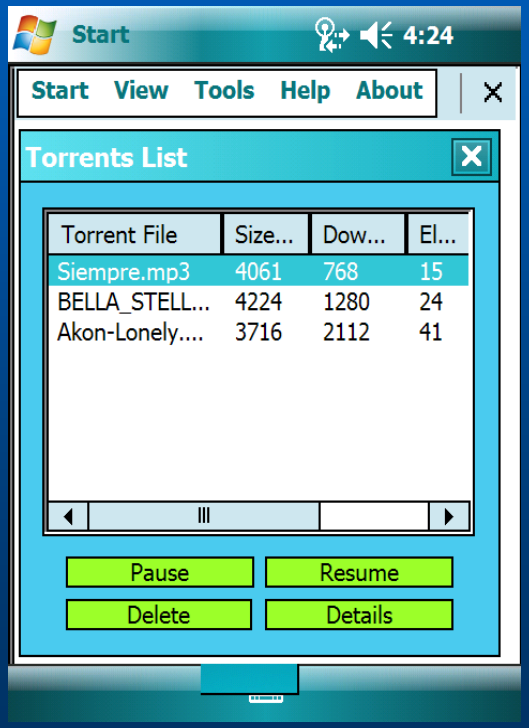
- A fully distributed network of wireless devices
- No infrastructure
  - Devices connected by wifi in ad hoc mode
- Sharing content:
  - Looking for content in the devices of others
  - Once found, share the content with others
  - Can be seen as BitTorrent in the Internet but adapted to wireless
    - Share with close devices to reduce resource consumption
    - Seeds take in charge the dissemination of the content in the network

18

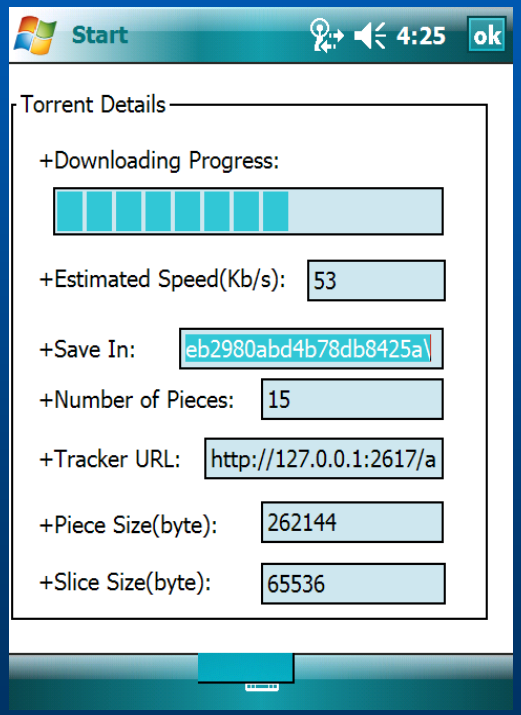
BitHoc:
Our solution for content sharing

- Available for download at http://planete.inria.fr/bithoc/
- Available for windows mobile

Main window



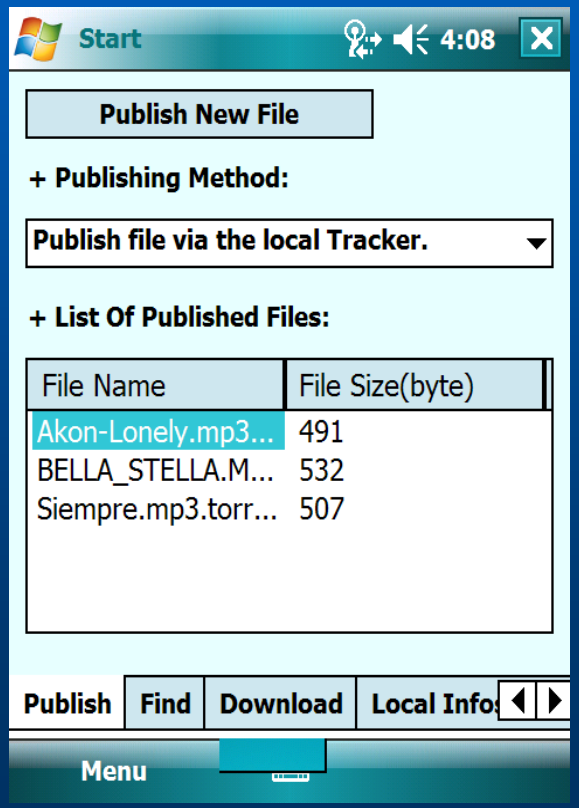
Real time control

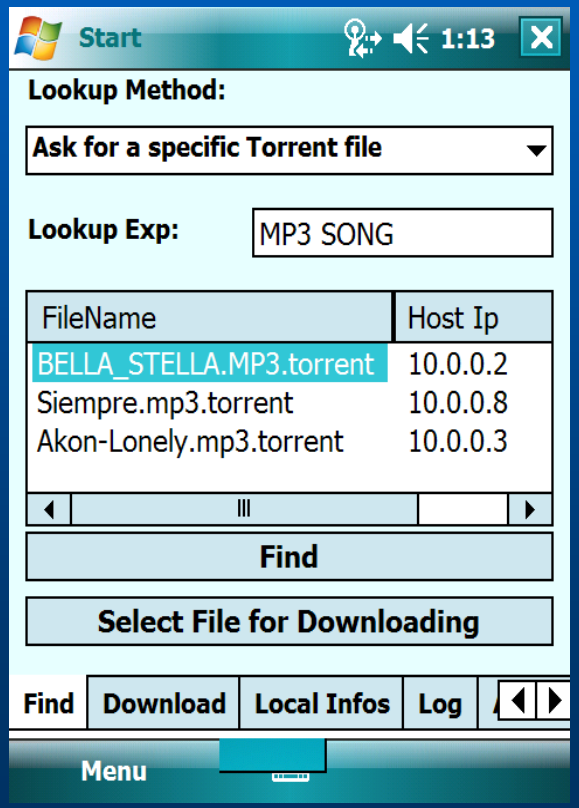


19

BitHoc:
Our solution for content sharing

- Publishing a content and searching for it





20

2. Network Security

- RFID security & privacy
- Wireless sensor network security
- Future Internet security

Network Security

- Embedded System Security
  - RFID Security and Privacy
    - Private Identification Protocol
    - Efficient Key exchange
  - WSN Security
    - Key establishment
    - Secure Aggregation
    - OS Security
      - Virus/worm
      - Code attestation
- Applications
  - CIP protection
  - Urban sensors

Network Security (2)

- Future Internet Security/ CyberSecurity
  - Objective1: Understanding current cyber-attacks/fraud, underground economy, Internet weaknesses.
    - Botnet monitoring
    - Localization of hidden malicious servers
    - Localization of TOR hidden servers
  - Objective2: Contribute to the Future Internet Architecture.
    - Secure positioning
    - Secure broadcast
    - OCN: Owner-Centric Networking

Owner-Centric Networking

- **Main Motivation**
  - When you publish on the Internet you lose control of your data
  - Think of Facebook users in 10 years!
- **Main ideas**
  - Users publish their contents but keep control
  - Can at anytime retrieve to modify or withdrawn
- **OCN Principles**
  - Users publish their contents on servers that they control
  - **Users exchange links, not contents!**
  - Users can only access documents via the links, cannot copy unless authorized
  - At anytime, users can modify their contents…

Example: OCN-email

Objet: -OCN email notification-
De: ccastel@inrialpes.fr
Date: Ven 27 février 2009 11:08
À: walid.dabbous@sophia.inria.fr
Copie à: kaafar@inrialpes.fr (plus)
Priorité : Normale
Filtrage du courrier: Automatiquement | De | Pour | Sujet
Options: Afficher l'en-tête complet | Voir la version imprimante | Télécharger en tant que fichier

```
You have received an OCN email from Claude Castelluccia.

To read it, click on this link:
http://planete.inrialpes.fr/~ccastel/ocn.txt

Thanks for using the OCN-email service.
```

3. Network Monitoring

- Troubleshooting of network anomalies
  - End to end or
  - Network solutions

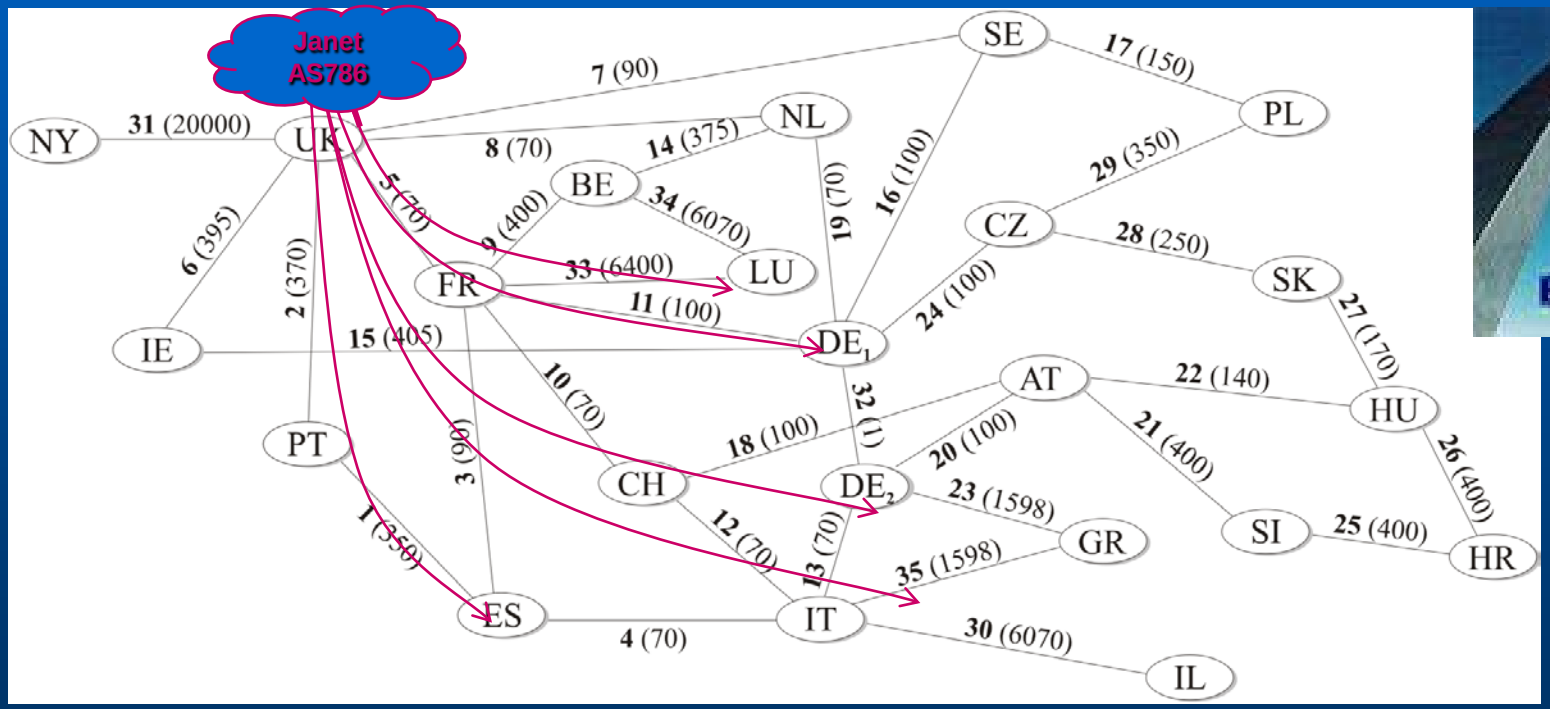
Efficient solutions for network and trafic monitoring

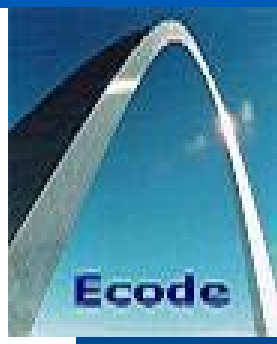
- Network troubleshooting
  - I am accessing a server.
  - There is a problem.
  - How can I localize the problem ? From me ? From the server ? In the middle ? How important is the anomaly ?
- Trafic classification
  - Applications encrypt their trafic
  - Can one use the packet size and time between packets to know the origin of each stream ? Web, FTP, SMTP, etc

27

Network-wide traffic monitoring

- Given a large network as GEANT. Operator interested in some OD flows. Where to place monitors ? How much to collect in each monitor ?





GEANT
European Research Network

An OD (Origin Destination) flow

28

Experimental Environment for future Internet architecture

- Mathematical modeling
  - Difficult to have “tractable” models
- Simulation (e.g. NS) is useful but not sufficient
  - Fast & “cheap”
  - Reproducible
  - Controllable
  - Not realistic networking conditions and code

4. Experimental testbeds

- Physical “research” testbeds
  - Local
  - Wide Area
    - Real networking stack
    - Controllable routers
    - Artificial networking conditions
- Overlays
- Virtual testbeds
  - PlanetLab, OneLab
  - Realistic networking conditions (to some extent)
  - Not controllable & Non reproducible

PlanetLab

- 815 machines spanning 405 sites and 35 countries
  nodes within a LAN-hop of > 2M users
- Supports *distributed virtualization*
  each of 350+ network services running in their own *slice*

Experimental Environment for future Internet architecture

- An integrated validation chain
  - Realistic models
  - Scalable Simulations
  - Controllable Experimentation
- A rigorous benchmarking methodology
  - Environment representation
  - Experiments results storage and comparaison

Experimental Environment for future Internet architecture

- Federating Research Testbeds
- Adding more heterogeneity to the PlanetLab testbed
- Making easier Experimentation
- Enhancing network simulations

Revisiting Protocols Evaluation

- Leverage on our experience on NS3 and Onelab
  - Experimental and simulation platforms
- Use collaboration with physicist
  - Non-linear/chaos theory
- ⇒ Revisit current protocols evaluation with new tools
  - ⇒ Expect to find new surprising results
  - ⇒ Make a methodological progress

Software

- NS-3 Simulator (www.nsnam.org)
- OneLab build of PlanetLab (www.onelab.eu)
- MultiCast Library Version 3
- LDPC large block FEC codec
- WisMon & Wextool
- WiMAX NS-3
- BitHoc
- …

Main Collaborations

- INRIA groups: Maestro, Trec, Temics, Hipercom
- French groups: LIP6, ENSICA, EURECOM/GET, INLN, LIA, U. Evry, etc.
- International groups: UCLA, UC Irvine, UCSC, U. Arizona, U. Lancaster, UMASS, Princeton U., U. Washington, U. Berne, EPFL, U. Pisa, RPI, etc.
- Industrials: Ericsson, Nokia, SUN, Docomo, Expway, Hitachi, Alcatel, FT R&D, LGE, STM, Motorola, Intel, Netcelo, NEC, Boeing, etc.

Planète project team

http://planete.inria.fr