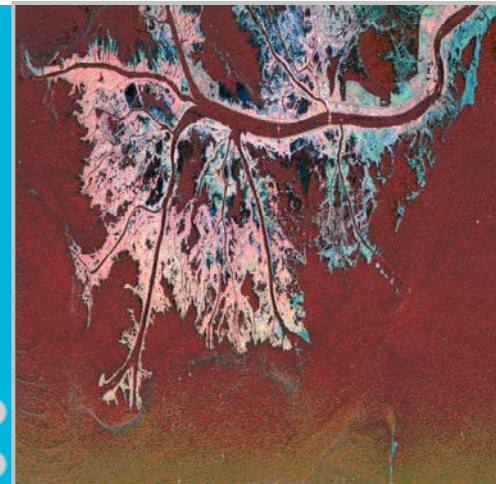
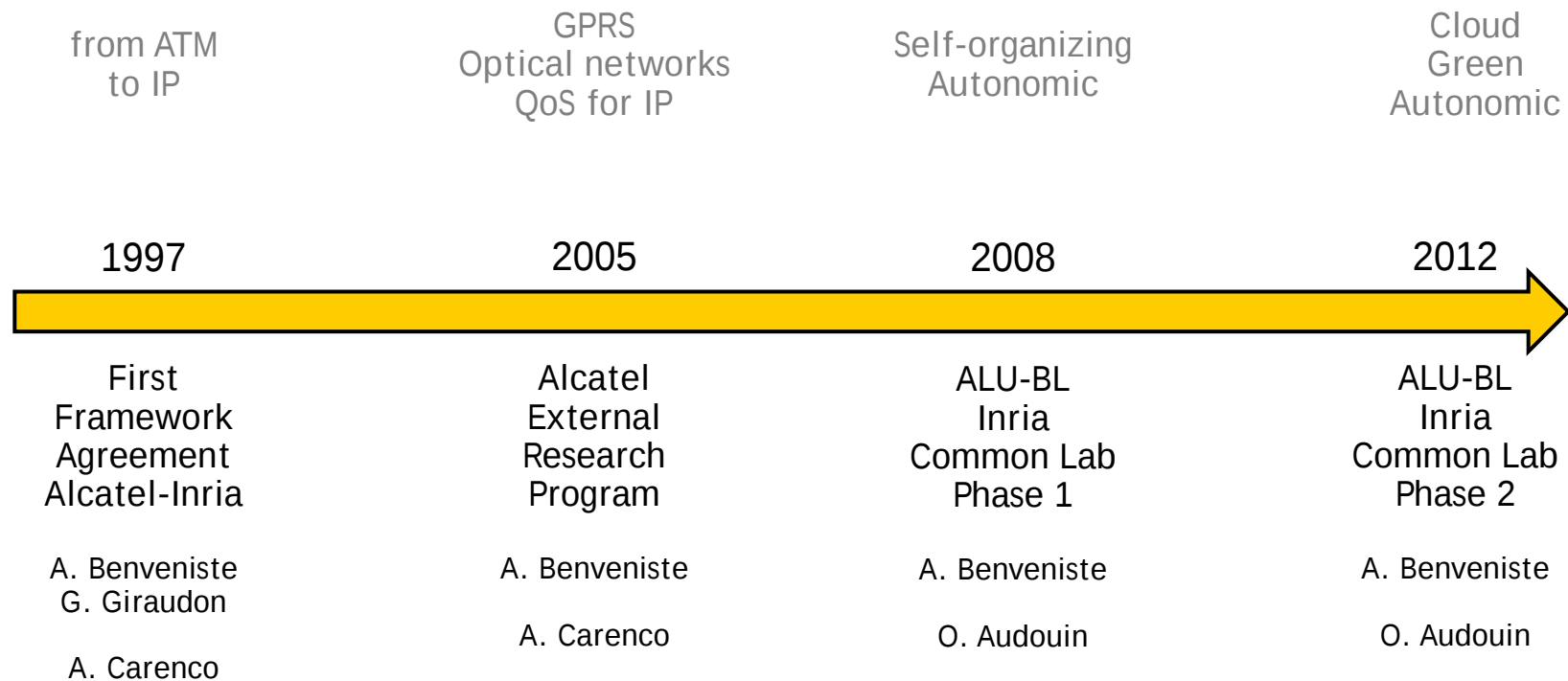


Inria / Alcatel Lucent Bell Labs Common Lab *sharing a vision of research*



O. Audouin & Albert Benveniste

A bit of history...



A light weight structure (Phase 1: 2008-2011)



55 researchers
15 PhD
11 Post-Doc × year

Murray-Hill



(Stuttgart)



A light weight structure (Phase 1: 2008-2011)



Cost of operating the structure $\approx$ 10 days / year for each Director

Defining
Research
Strategy

Directors

O. Audouin (ALU)
A. Benveniste (Inria)

SCIENTIFIC COMMITTEE

F. Baccelli, W. Dabbous (Inria)
V. Kumar, L. Thomas, M. Vigoureux (ALU-BL)

Sharing
the Vision

Brainstorming, Seminars

Operating
Research
Activities

High Manageability

P. Peloso (ALU)
E. Fabre (Inria)

Semantic Networking

L. Noirie (ALU)
I. Guerrin-Lassous (Inria)

Self-Optimised Wireless Networks

L. Rouillet (ALU)
B. Gaujal & V. Roca (Inria)



Results of Phase 1: key figures

Publications: 95 (among which $\approx 35\%$ are joint)

Patents: 13

Seed technologies (industrialization in progress or for consideration):

- Autonomic Channel Power Tuning in an Optical Network; distributed constrained convex optimization
- Self-configuration and self-tuning of wireless cellular networks; Voronoi based models, coverage processes, random spatial trees, Gibbs random fields
- Flow aware routing based on DPI and statistical analyses

Projects born: *IP-Univerself* (HiMa), *ANR-ARSSO* and *ECOSCELLS* (SelfNets)

People:

- Calvin Chen TREC → BL Villarceaux + LINCS
- Amira Alloum → software architect in wireless BD

Two sample results: Autonomic Wavelength Power Tuning in a Photonic Network



Challenges:

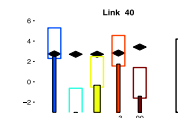
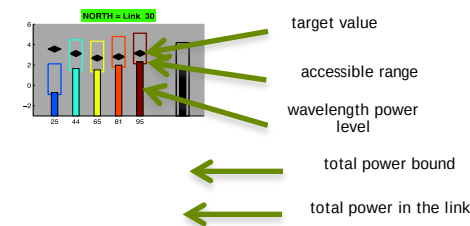
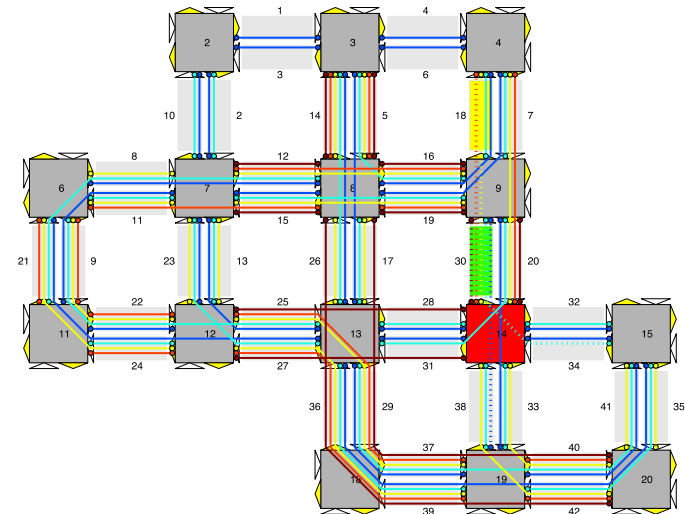
- optimize optical reach without regeneration
- optimize & equalize quality of all connections
- **avoid manual tuning, and over-dimensioning**
- better use of available resources

Distributed and adaptive solution:

- huge non-linear constrained optimization problem
- **distributed P2P tuning (at node scale),** derived from Markov fields inference techniques
- **dynamic optimal power (re)allocation when connections join/leave**

Results:

- ALU simulations:
50% reduction in regeneration equipment
- **2 joint ALU-Inria patents**



- (Gibbs sampler) to explore the discrete tridimensional space $\{\text{power}; \text{user-association}; \text{channel-allocation}\}$ and converge to an optimal configuration.

Diagram illustrating a two-tier cellular network structure:

- Macro cell (MC) BS:** The outer red circle represents the macro cell. The base station (BS) is labeled $(P_{\max} = 40W)$.
- Small cell (SC) BS:** The inner blue circle represents the small cell. The base station (BS) is labeled $(P_{\max} = 1W)$.
- Mobile Devices:** Two mobile devices are shown, labeled v and u .
- Downlink Channels:**
 - Red dashed line from MC BS to device v is labeled $l(b, u)$.
 - Red solid line from MC BS to device u is labeled s .
 - Blue dashed line from SC BS to device u is labeled I .
- Label:** The word Downlink is written at the bottom, indicating the direction of communication.

Tunable for a variety of contexts

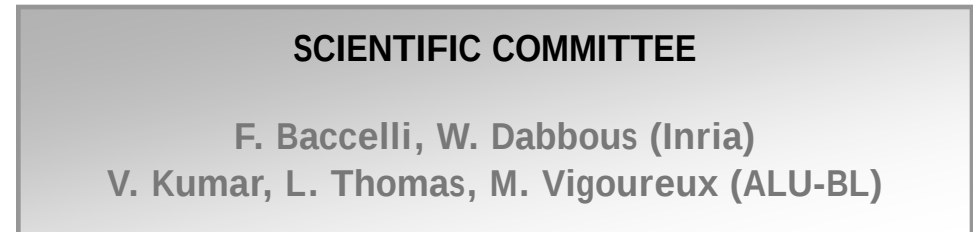
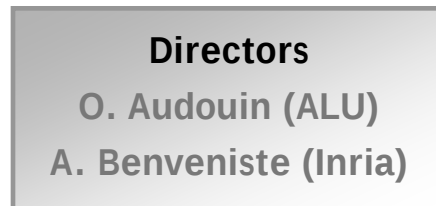
3 Patents, 3 joint publications

$$\mathcal{E}_u = \underbrace{\frac{N_u + \sum_{v \neq u} P_v(c_u) l(b_v, u, c_u)}{P_u(c_u) l(b_u, u, c_u)}}_{=1/(\text{SINR}_u)} + \underbrace{\sum_{v \neq u} \frac{P_u(c_v) l(b_u, v, c_v)}{P_v(c_v) l(b_v, v, c_v)}}_{\text{Altruistic part}}$$

Phase 2: 2012-2015



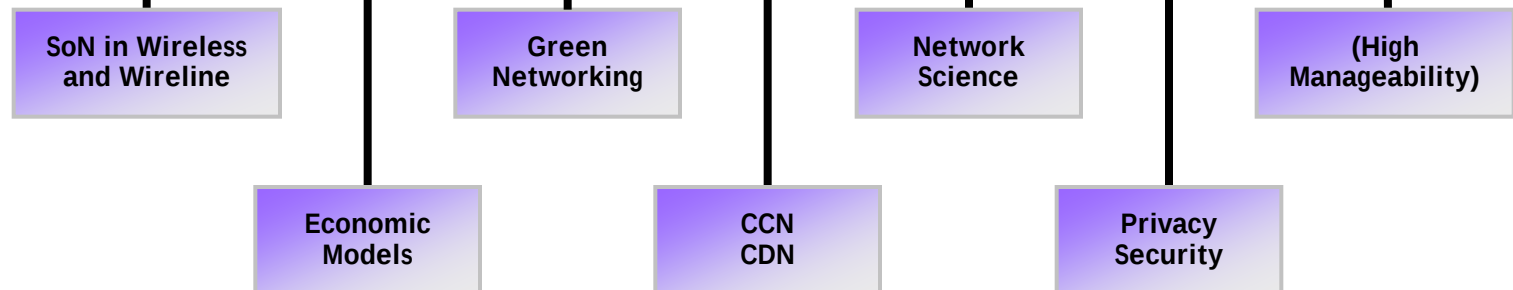
Defining
Research
Strategy



Sharing
the Vision



Operating
Research
Activities





Concluding remarks

Benefits for ALU Benefits for Inria

Giving breathing to research thanks
to longer time scales

Accessing some breakthrough
technologies & mastering

Jointly developing technologies with
externals skills

Structuring effect

Brain drain

Better understanding strategic
industrial issues

Discovering new problems for
research

Jointly developing research with
externals skills

Structuring effect

At a low cost



W www.alcatel-lucent.com
w www.inria.fr

