Radio over Fiber Distributed Antenna Systems for Wireless Communications

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Outline

- Introduction: Radio over Fiber (RoF)
- Multiple Services over Fiber
- Indoor Application: WiFi Network demonstrator
- Outdoor Applications: Distributed Antenna System for Corridors

Radio over Fiber

Conventional,
distributed network electronics

Wireless
Access Point

Head-end controller

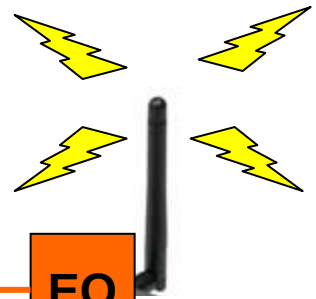
Centralized networks electronics

Head-end controller

EO

Fiber optic link

EO



Large Range for Optically Transported RF Signals

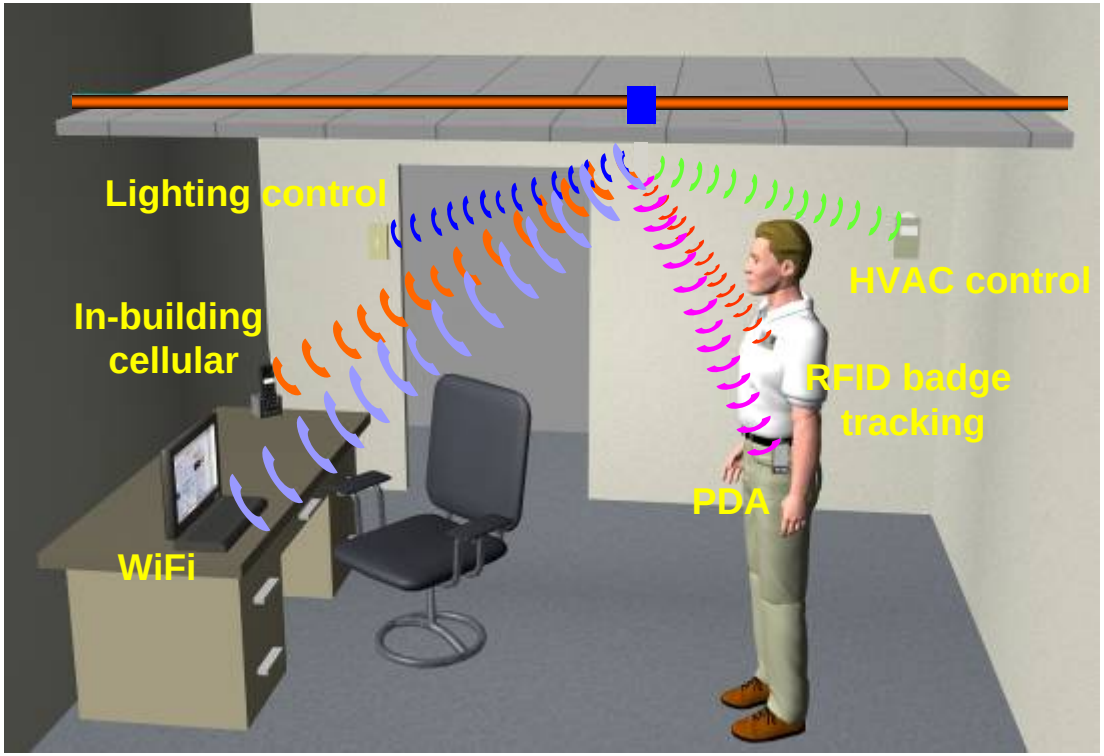
Preamplifier Gain (dB)	38
Preamplifier Noise Figure (dB)	2.9
Postamplifier Gain (dB)	25
Laser Bias Current (mA)	8
Laser Slope Efficiency (W/A)	0.075
Laser RIN (dBc/Hz)	-137.7
Laser OIP3 (dBm)	16
Detector Responsivity (A/W)	0.65
TIA eff. noise density (pA/$\sqrt{\text{Hz}}$)	10

Component parameters used for spurious free dynamic range calculation

Feasible transmission distances over various fiber types at 5.8 GHz and SFDR of 95 dB·Hz$^{2/3}$

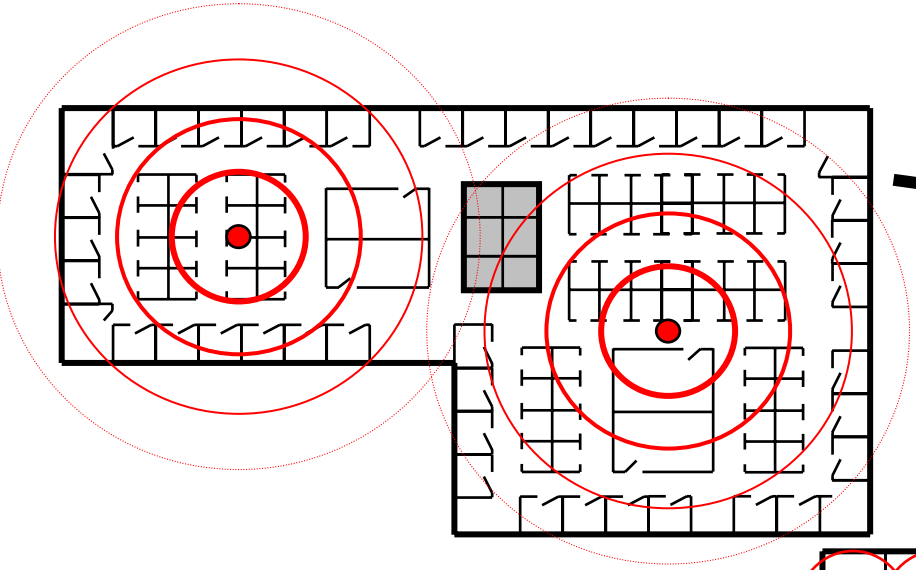
850 nm OM2 MMF	**80 m**
850 nm OM3 MMF	**>300 m**
1300 nm single-mode fiber	**38.7 km**
1550 nm single-mode fiber	**67.7 km**

RoF Advantages



- Easy deployment of many access points or distributed antenna
- Fiber can support multiple wireless services at different frequencies
- Services added and controlled at centralized hub

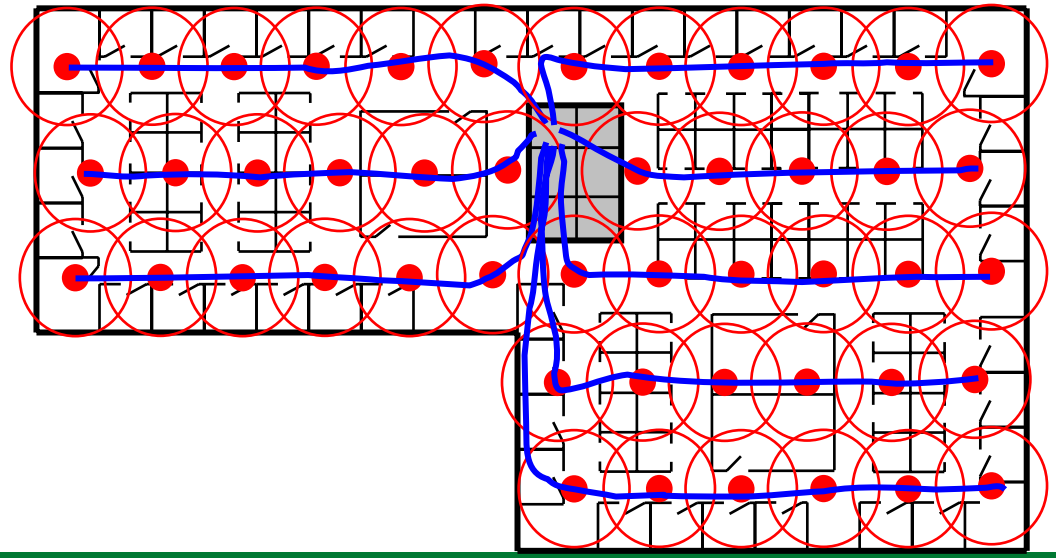
Indoor RoF Application: Indoor WiFi



Current trend is going from larger to smaller, higher BW cells

- Bandwidth for few users
- Ubiquitous coverage
- No out-of building leakage

- Bandwidth shared by many users
- Dead spots
- Coverage out of the building



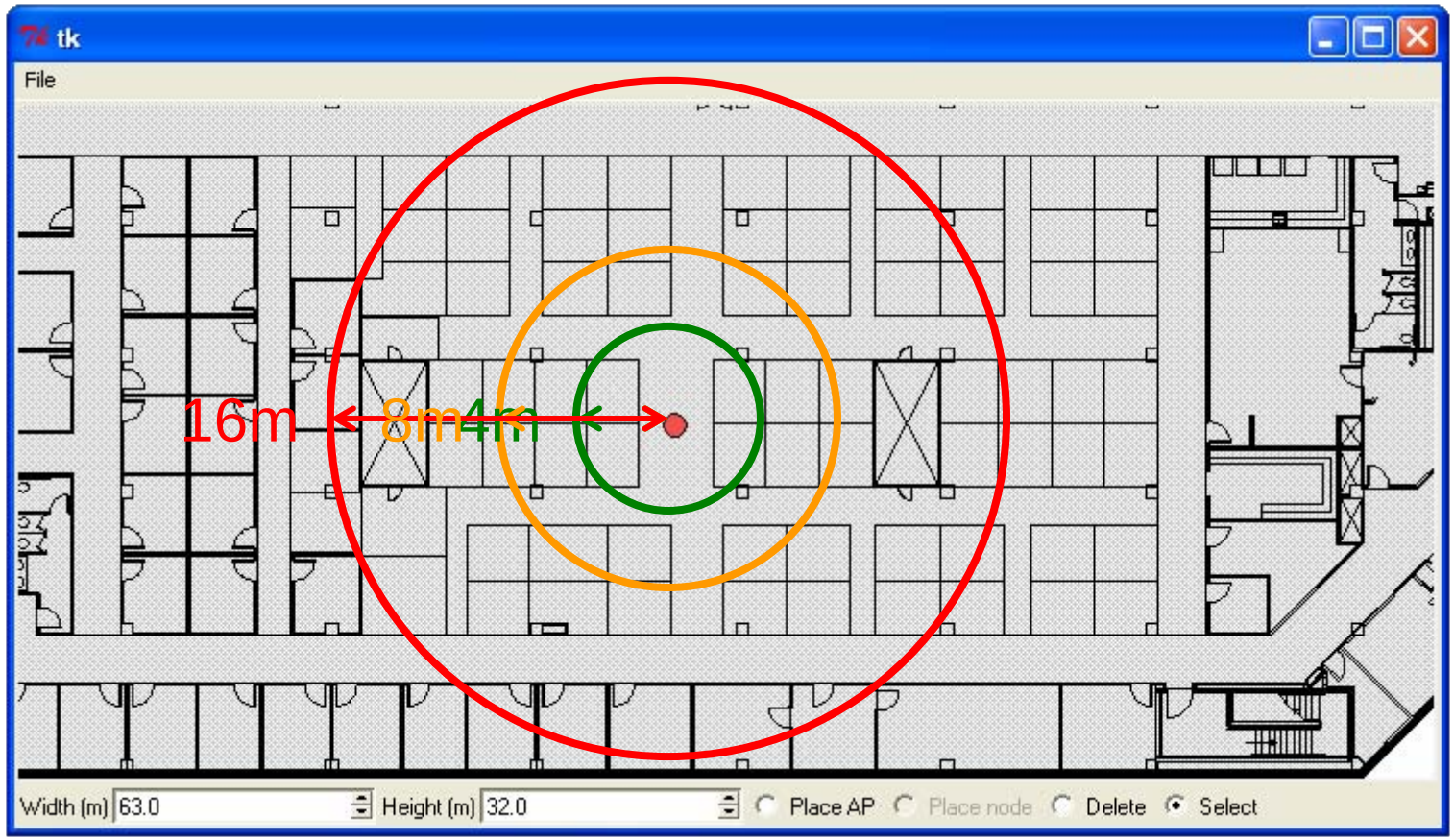
Indoor WiFi Applications

Large WiFi cells can have poor performance in office environments

4 users

14 users

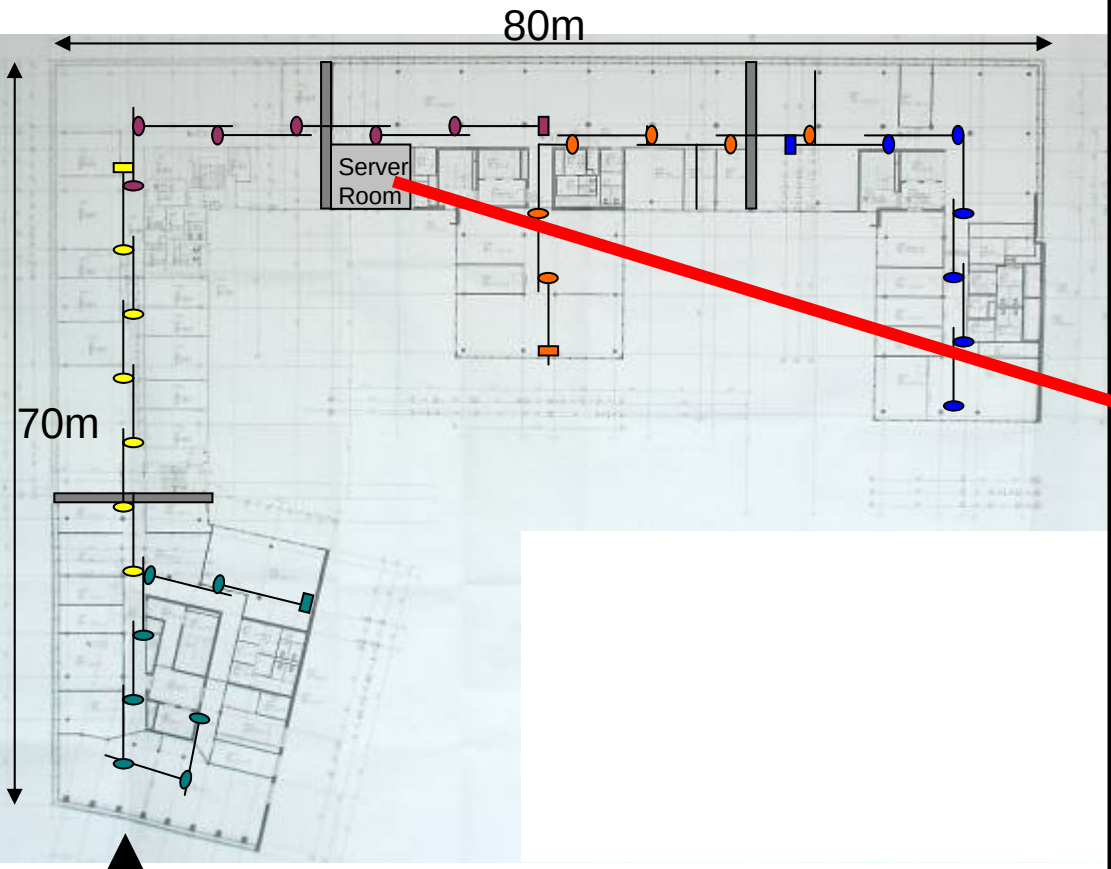
56 users



Conference Room on a Busy Day

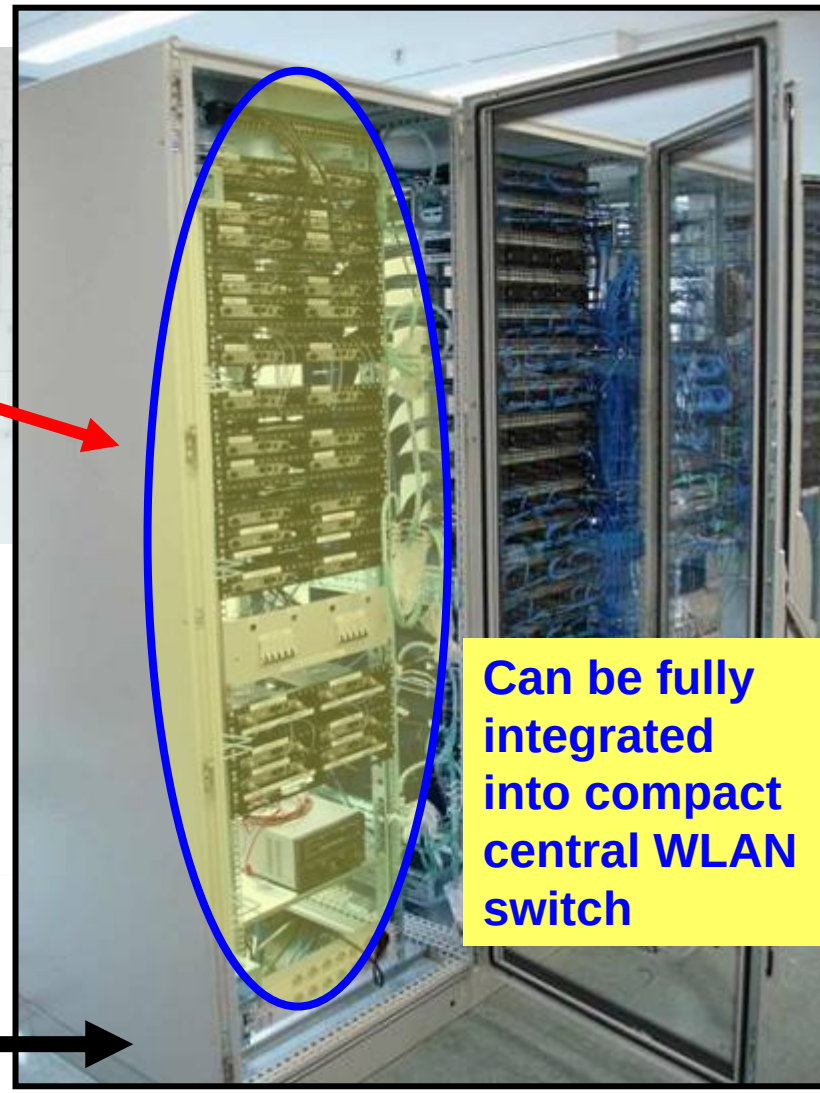
time	19.04.2007 12:30	19.04.2007 16:30	20.04.2007 10:00	20.04.2007 13:15	24.04.2007 13:30	24.04.2007 17:15	25.04.2007 08:30	25.04.2007 11:00	25.04.2007 13:30	26.04.2007 08:30	26.04.2007 13:30
AP#											
11	1	1	1		2				2	2	1
12	1			1	1	2	1	3	1		1
13											
14		1	1		3	5		4	4		
15	1	1		1	2	1		1	3	1	1
16							1	1	1		
21	2	2	2	3				2	2		1
22		1	2	1		2	1				
23											
24	1				4	2					
25	1	2				1					
26			1								
31											
32											
33					2	2		1	1		1
34	1	1					1			2	
35						2			1		1
36											
41					3	1	1	1	1		
42							1	1	2		
43	11				2				2	1	
44	3	2	2	1	2	2	1	2	2	3	
45								1			2
46					3	2	1	2	1	3	6
51					6	8	1	8	7	2	2
52	1				7	3	5	6	6	3	2
53								1			
54									1		
55	3	2			1	2	4	6	5	8	8
56							4	3	3	6	4
totals	26	13	9	7	38	35	22	43	45	31	30

30-cell demonstrator network (WLAN over MMF)



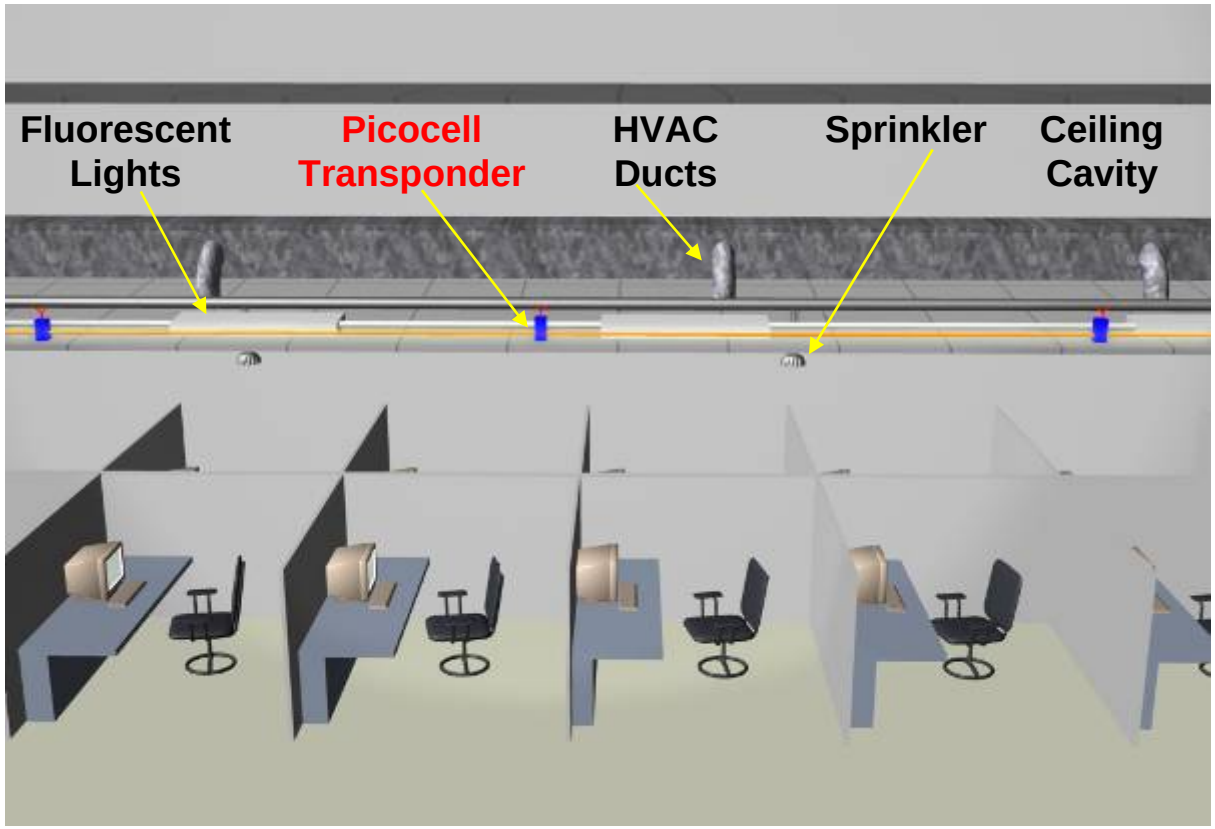
Layout

Head-end Implementation



Can be fully integrated into compact central WLAN switch

Rapid deployment: multiple antennas, one cable run



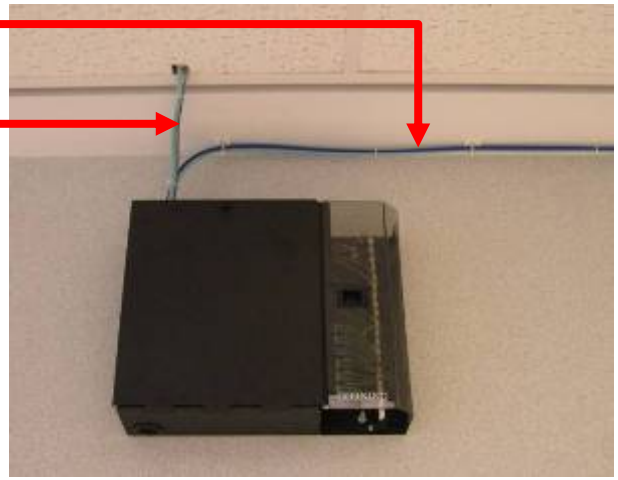
Pre-fabricated optical fiber antenna array cables pulled into ceiling cavity

Multiple cell fiber-radio WLAN installation

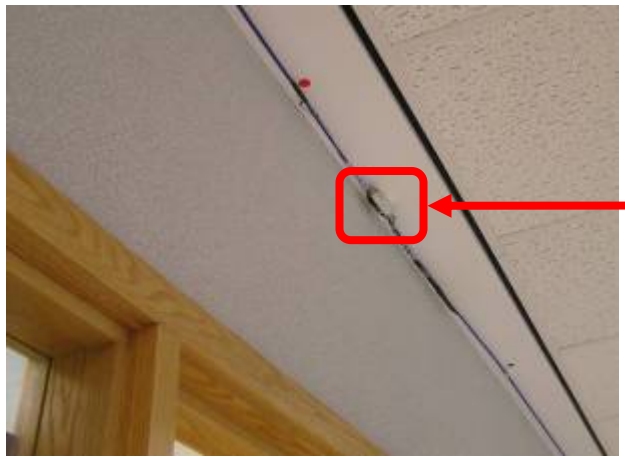
Fiber Interconnect Housing

Cable to antennas

Backbone Cable

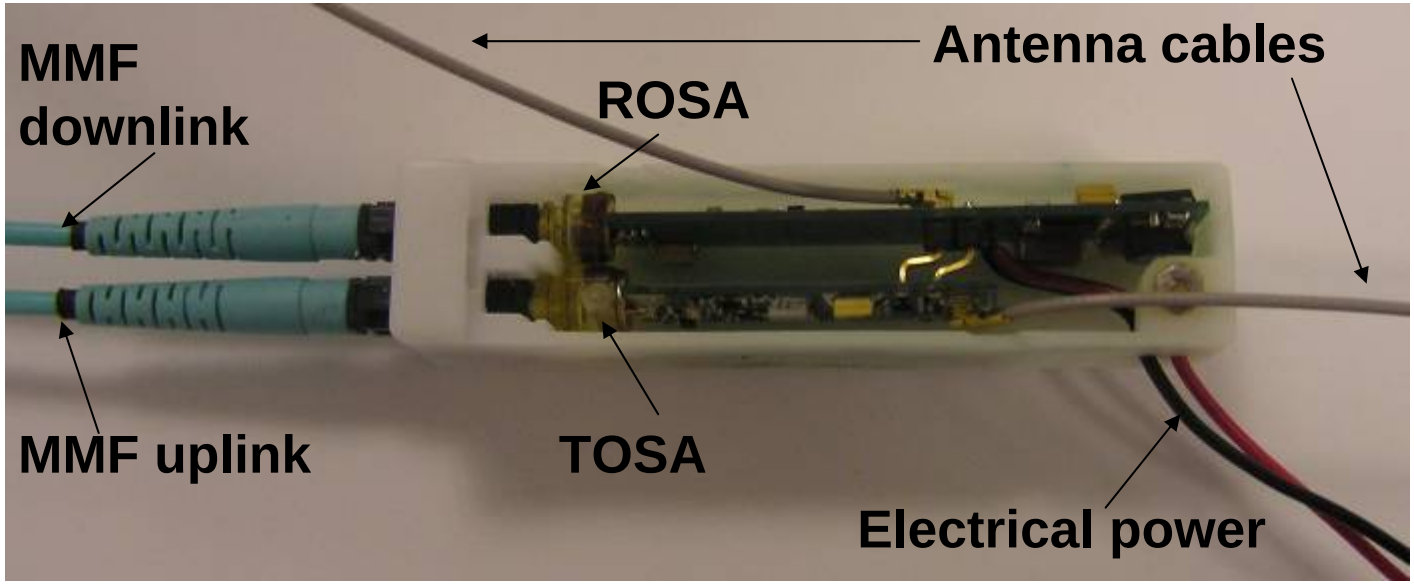


Cable feeding remote antennas

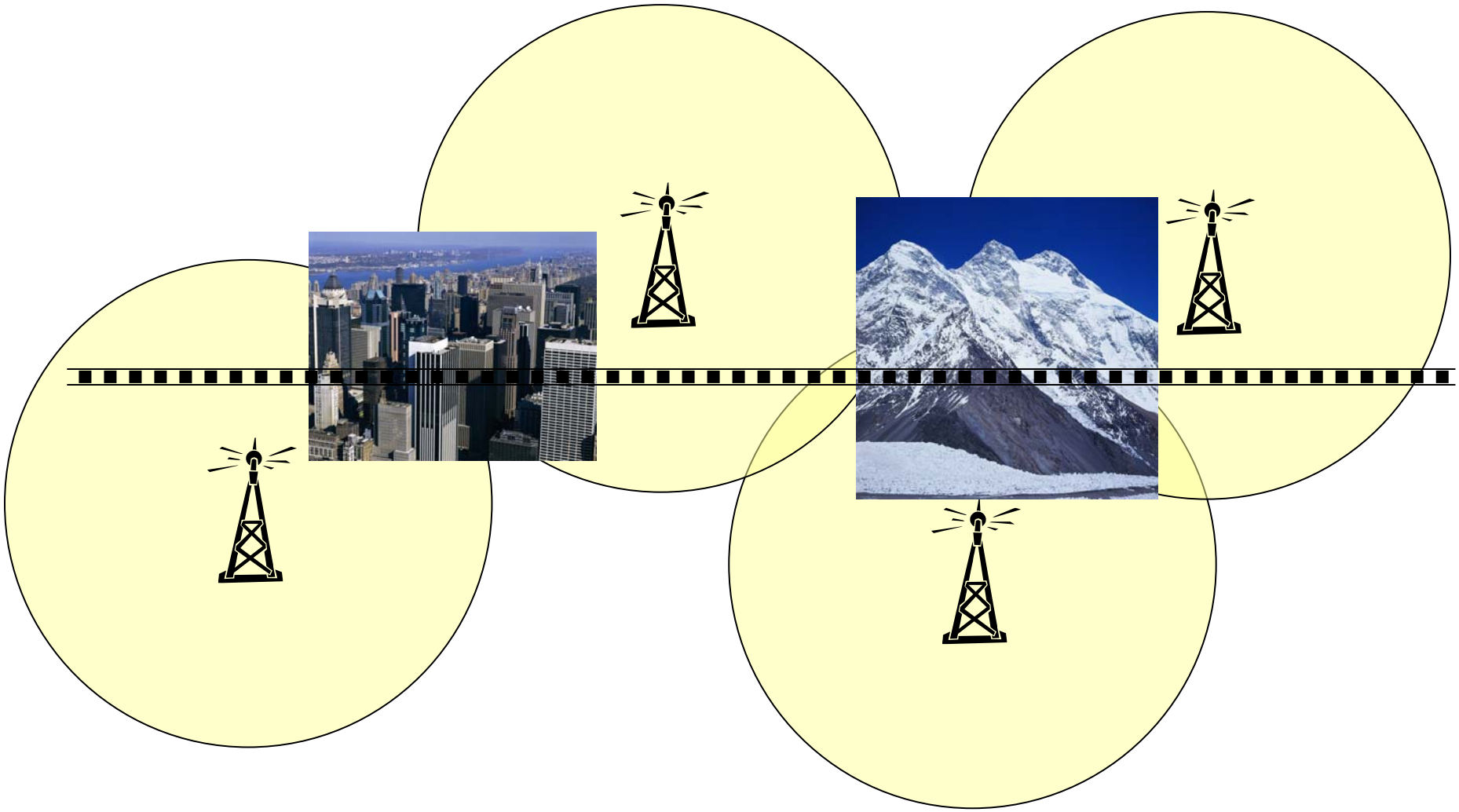


Antenna Transponder

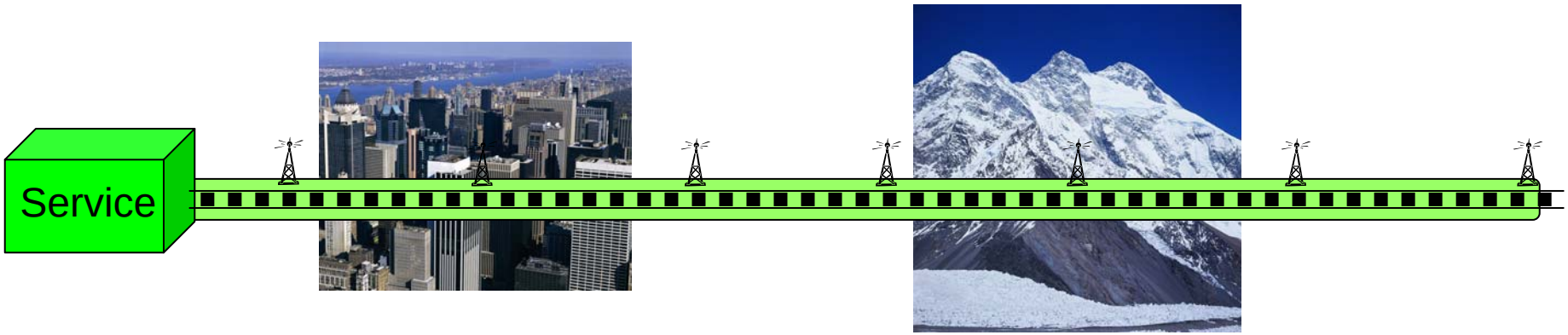
Example of antenna transponder implementation



Outdoor Application: Coverage for Narrow Corridors (Roads & Tracks) in Difficult Terrain



Outdoor Application: RoF Distributed Antenna System Deployed Along Corridor



Summary

- Radio over Fiber can provide multiservice solutions
- Indoor deployment and management can be easier than traditional wireless deployments
- Long range transport of signals good for extending coverage along corridors

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