NOKIA

Bridging the Digital Divide
- Update on Nokia Broadband

Nokia - Broadband Arizona Agenda

- Nokia Overview
- What is happening in Broadband Market
- Digital Divide
- Nokia's Solutions
  - Connected School District Solution
  - NDAC
  - CBRS / C-BAND
  - FastMile
  - FTTH/NG-PON
- Business Models (PPP)
- References

NOKIA

A worldwide home

We operate in 100+ countries

in North America

where we have been at the heart of the Bell system for a hundred years

in Europe

where we are rooted and headquartered

in Asia

where we employ more people than anywhere else

NOKIA

We create the technology to connect the world

€23.3bn

Annual revenue 2019

€129bn

in R&D investment (past two decades)

98,000

Employees

World's fastest 5G

#1

in telco software

#2

in global telecom infrastructure

$9.9bn

Our brand value

NOKIA

Nokia Business & Technology Groups

We create the technology to connect the world

Mobile Networks (MN)

We help meet customer demands for mobile content and connectivity

Fixed Networks (FN)

We help our customers to deliver the best broadband experience to everyone, everywhere

IP/Optical Networks (ION)

We help our customers connect everyone and everything to the cloud, every time

Nokia Enterprise

We enable the digitalization of asset-intensive industries with mission and business critical needs

Global Services (GS)

We help our customers navigate through complexity and transform their business

Nokia Software

We help our customers enrich and monetize digital experiences through the power of connected intelligence

Nokia Technologies

We license intellectual property, including our patent portfolio and technologies as well as the Nokia brand

Nokia Bell Labs

We are solving great industry challenges with disruptive inventions

83 commercial 5G deals in key markets | 32 Nokia live 5G references

● Nokia live 5G references

North America

CA
- ● Bell Shaw
- TELUS

US
- ● at&t
- ● Sprint
- ● T-Mobile
- US Cellular
- ● verizon

Latin America

AW
- SETAR

UY
- antel

152 commercial 5G engagements

70+ technical engagements

Europe

FI
- ● Telia
- ● elisa
- SANDVIK

UK
- ● 3
- ● O2

DE
- DB
- O2

FR
- free mobile
- orange
- SFR

CH
- Salt.

IT
- ● vodafone
- iliad

A
- ● A1

LVA
- lmt

SK
- orange

Middle East

SA
- ● STC
- ● zain
- mobily

AE
- ● du

QA
- ● ooredoo

Asia

CN
- ● 中国移动 China Mobile
- ● 中国电信 CHINA TELECOM
- China unicom 中国联通

JP
- ● KDDI
- ● SoftBank
- docomo
- TPEC

KR
- ● LG U+
- ● SK telecom
- ● kt

TWN
- ● 中華電信 Chunghwa Telecom
- T STAR 台湾之星
- ● Taiwan Mobile

Oceania

GUM
- ● docomo pacific

AU
- ● vodafone
- ● OPTUS

NZ
- ● vodafone
- ● Spark NZ

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Key 5G References – North America

- **T-Mobile and Nokia Ink $3.5 Billion, Multi-year 5G Network Agreement (July 30, 2018) -** Nokia's largest 5G agreement globally will provide end-to-end 5G solutions for T-Mobile's nationwide 5G network
- https://www.t-mobile.com/news/press/nokia-5g-agreement
- **AT&T Makes World's First Standards-Based Mobile 5G Millimeter Wave Connection (Sep 10, 2018)**
- https://about.att.com/story/2018/5g_cities_2018_2019.html
- **Sprint's mobile 5G service in nine top U.S. cities to launch in first half of 2019 covering more than 1,000 total square miles (Feb 25, 2019)**
- https://newsroom.sprint.com/sprint-announces-commercial-5g-service-to-launch-in-may-starting-in-chicago-atlanta-dallas-and-kansas-city.htm
- https://www.youtube.com/watch?v=Hqiz0EwP6W8
- **Nokia and Verizon celebrate 5G in action**
- https://www.youtube.com/watch?v=3YAlisSeBys

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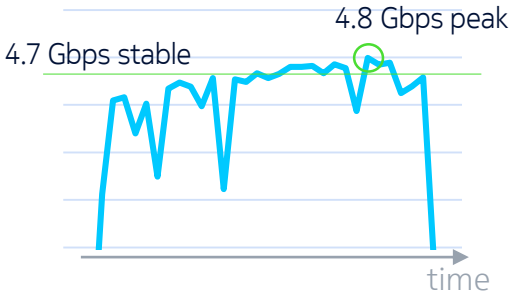
US: 4.7 Gbps using Nokia's commercial 5G software and hardware

Fastest 5G speeds recorded to date in a dual connectivity setup

4.7 Gbps

840 MHz, EN-DC

5G: 8 x 100MHz (28 GHz, 39 GHz)
4G: 2x20 MHz (B2)



- ✓ AirScale: Commercial SW and HW
- ✓ Both classic and cloud
- ✓ More than our competitors can claim (May'20)

Forbes

World's Fastest 5G: Nokia Beats Ericsson With New 5G Speed Record

Carly Page Contributor ⓘ
Consumer Tech
I cover Tech in Europe, including big tech, PC hardware and telecoms

Nokia has set a new 5G record, achieving speeds of 4.7 Gbps at its Over-the-Air (OTA) network in ... [+]

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Extraordinary Opportunities through High Impact Use Cases

1 Video surveillance & analytics

2 Machine remote control

3 Connected vehicles

4 Cloud robotics & process automation

5 eHealth

6 Fixed Wireless Access

7 Immersive experience

8 Smart Stadium

https://www.nokia.com/networks/5g/use-cases/

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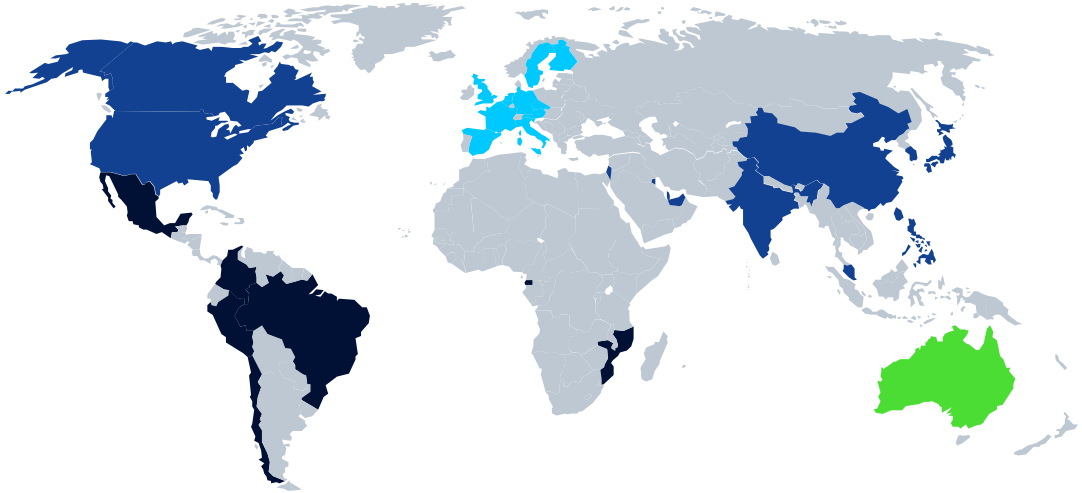
Nokia's experience in vertical markets

Public sector	References 240+	• Government broadband • Smart/connected cities	• Defence • Public safety
Transportation	References 100+	• Railways • Highways & roads • Aviation	• Maritime • Air-to-ground network
Energy	References 200+	• Utilities • Oil & Gas	• Mining
TXLE Webscale	References 20+	• Manufacturers • Webscale	• Venues • Logistic

180+ private wireless customers

Uncontested market leader in private wireless



Public References

Latest additions

Lufthansa Technik

TOYOTA Production Engineering Company TPEC

Home Office with EE

EWA هيئة الكهرباء والماء Electricity & Water Authority

NIPPON STEEL with NS Solutions

NORCAT

Société du Grand Paris

brussels airport

Infrastructure Networks

BMW 华晨宝马

ELEKTRO

RioTinto

Vienna International Airport

Ameren

FINAVIA

CARGOTEC

KOKKOLAN SATAMA

beach

CITY OF TAMPERE

PORT OULU

KONECRANES

LUT University

ALTAN REDES

Etteplan

conectar4GRO

东方明珠

SANDVIK

KR network

STEVECO

NOKIA

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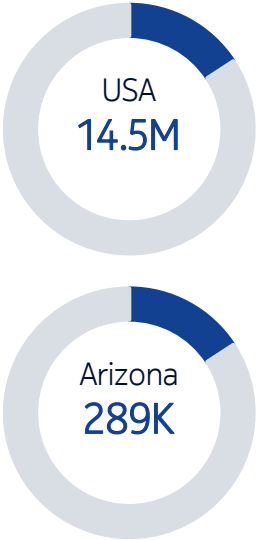
Go Allwhere.

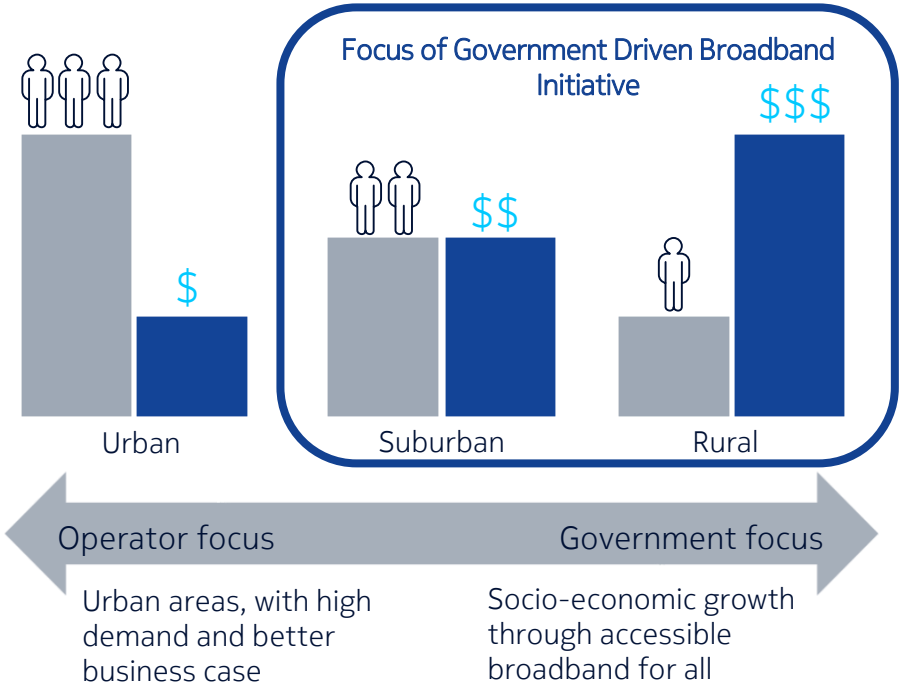
Digital Divide

Governments are key player in broadband availability

of Households **without** internet access



Source: https://connectednation.org/blog/2019/10/09/new-u-s-census-findings-number-of-households-without-internet-access/



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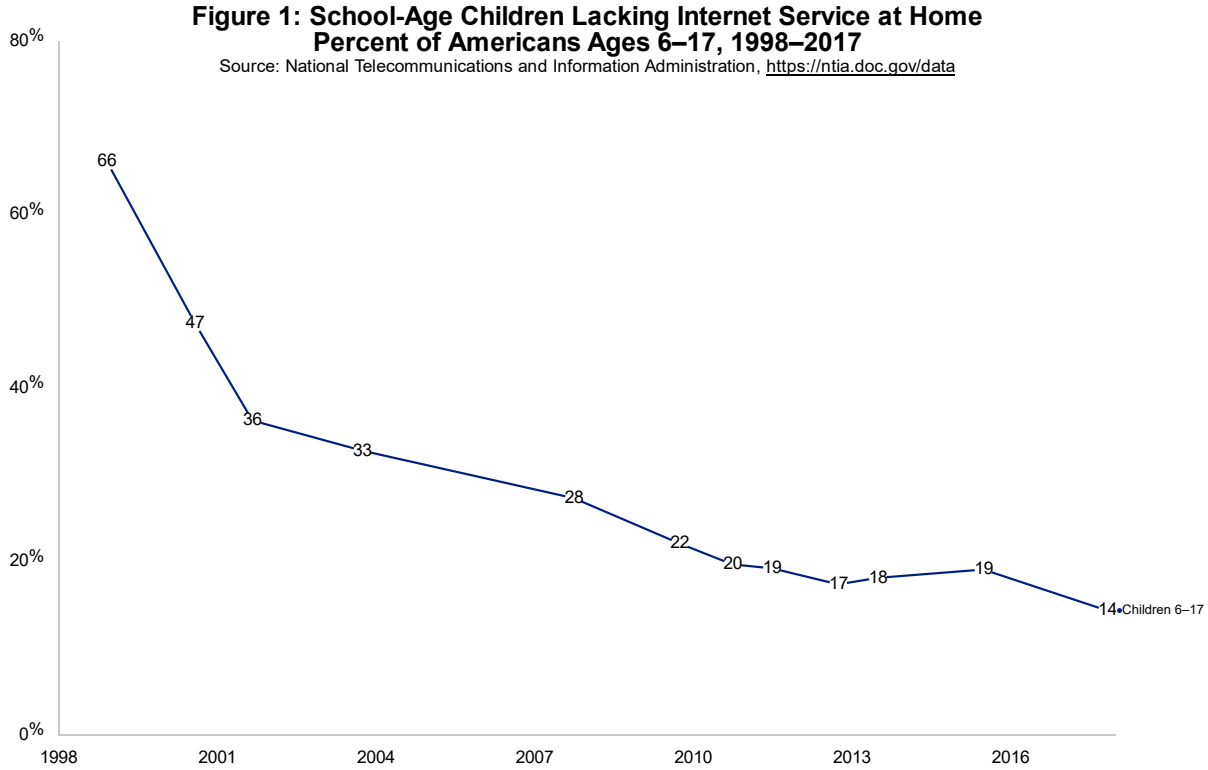
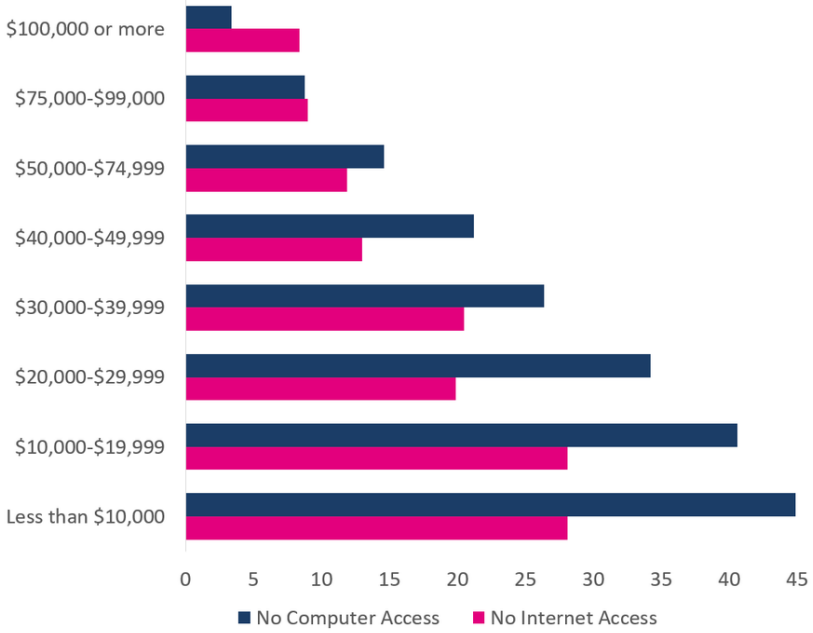
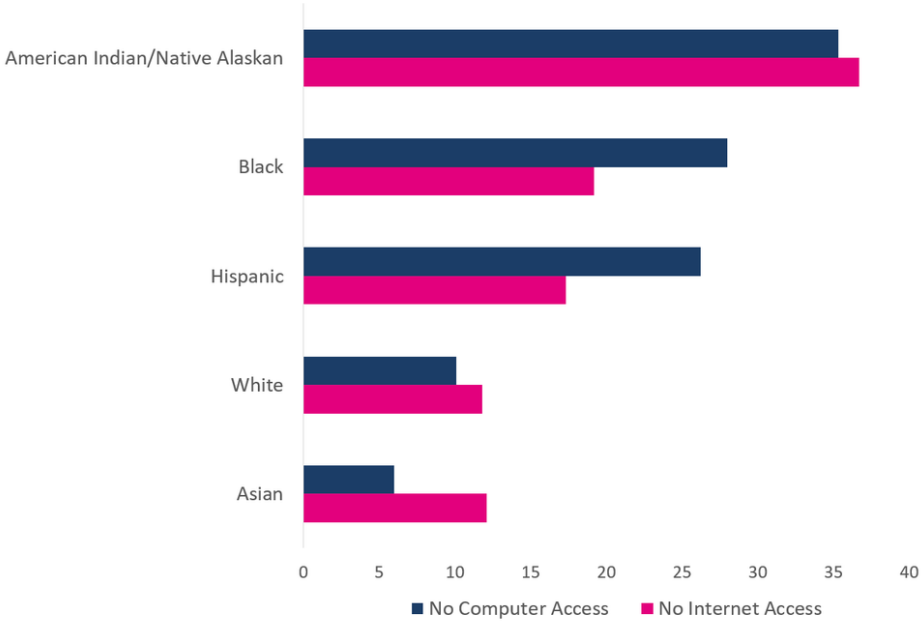
7 million school-age children live in households without home internet service



Lack of computer and internet access varies by income and race





Source: https://usafacts.org/articles/internet-access-students-at-home/

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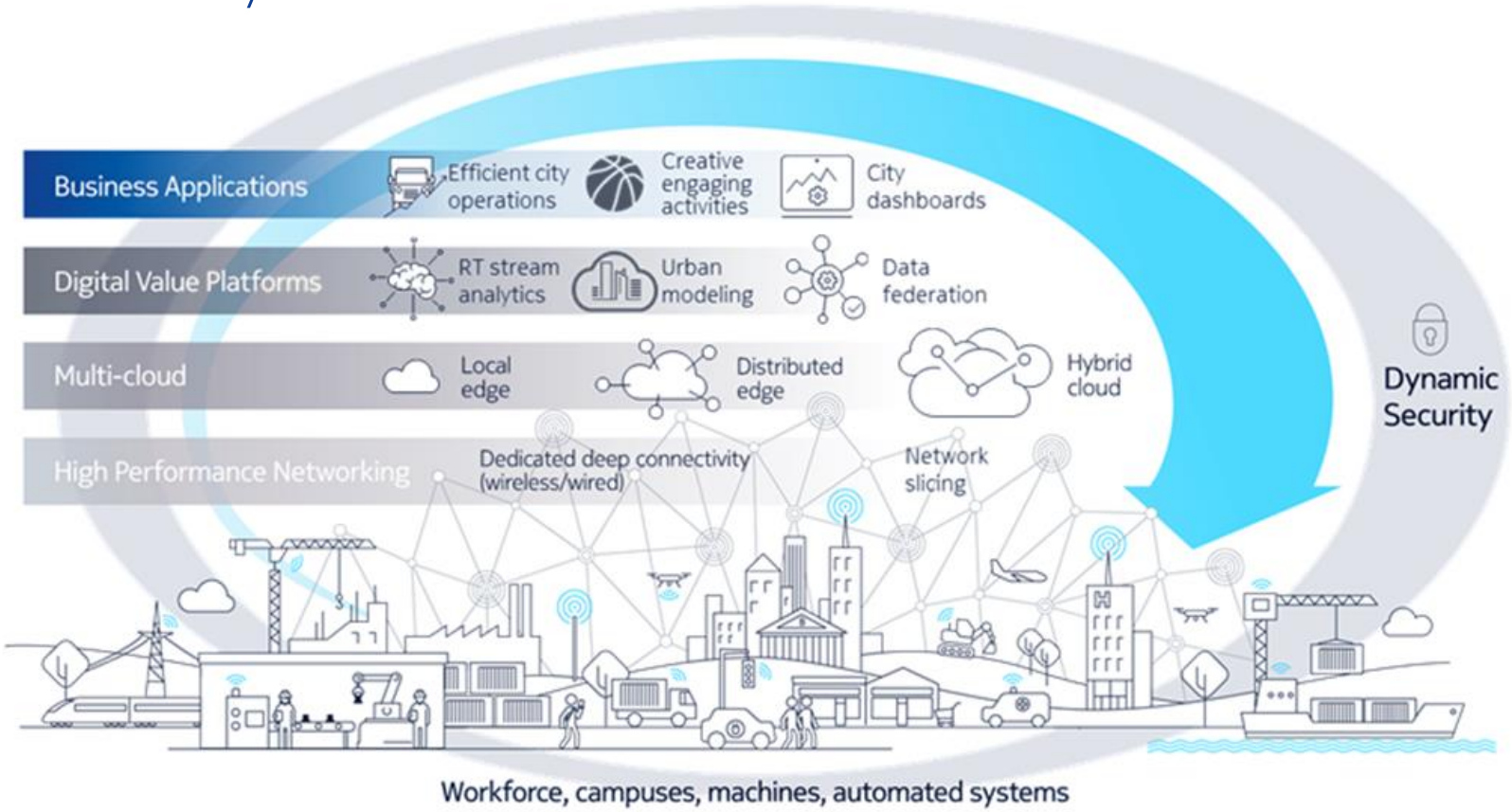
Go Allwhere.

Nokia solutions

Future X City Network



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The Connected School District

Enabled by a Secure, High Speed, Cost Effective Private Wireless Network

Remote Learning
Provide in- home and on-bus broadband for student learning

Safety
Security video on campus and bus

Disaster Support
Student connectivity during disasters

Cost Reduction
Reduce ongoing carrier costs

Campus Communication
Voice communication for security, maintenance & support personnel

Fixed Broadband to Student Homes

Mobile Broadband for vehicles

Push to talk, Push to video

Asset Tracking

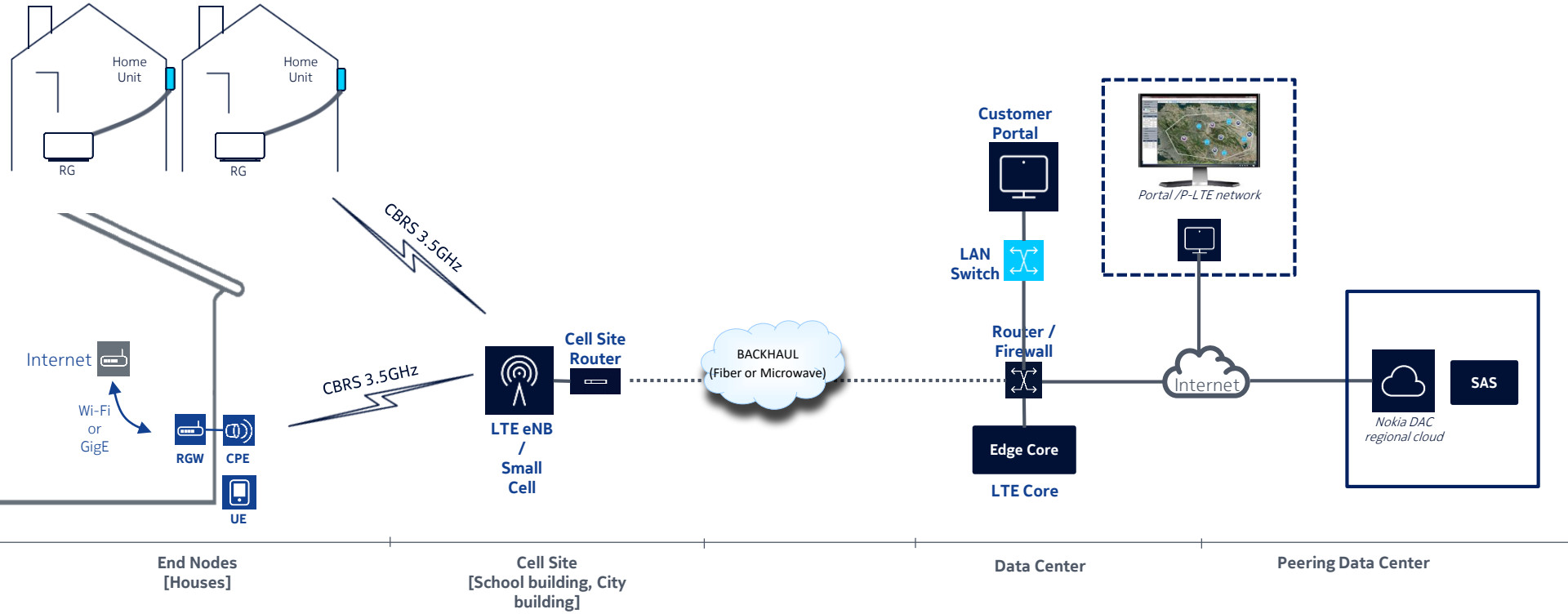
Secure flexible networking

Video and analytics

Private LTE Network (with seamless upgrade to 5G)

NOKIA

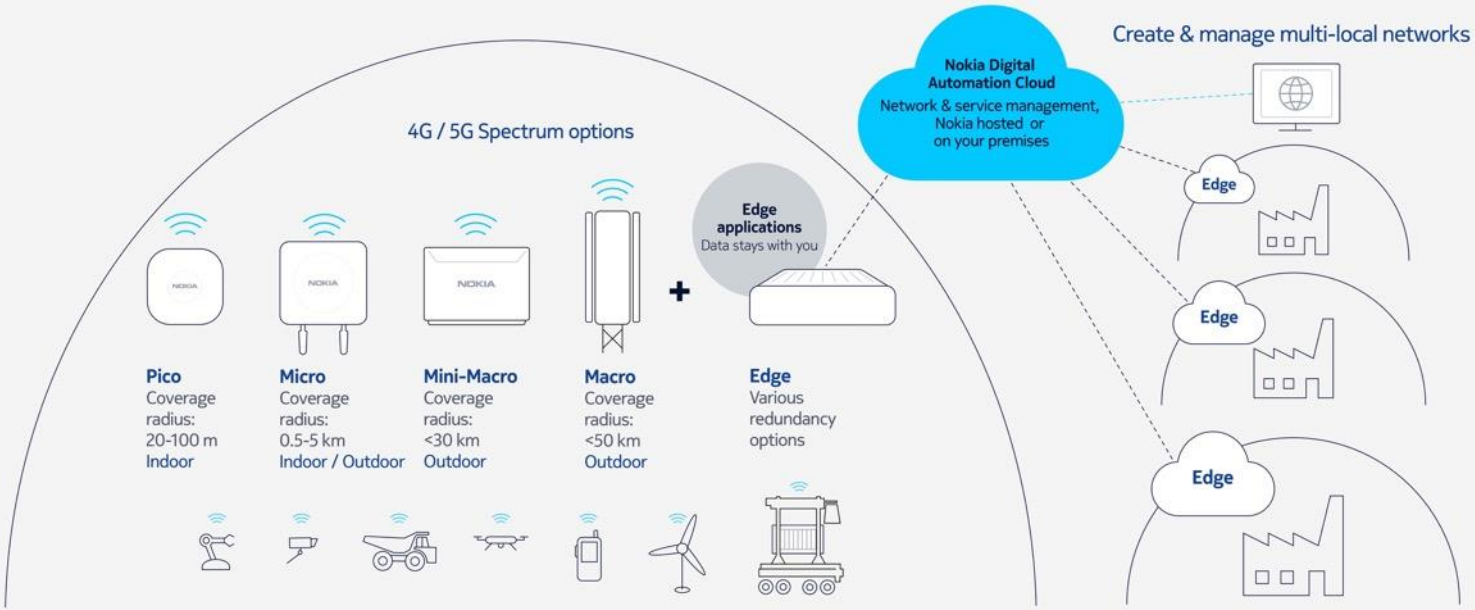
Private LTE Solution Example for ISD



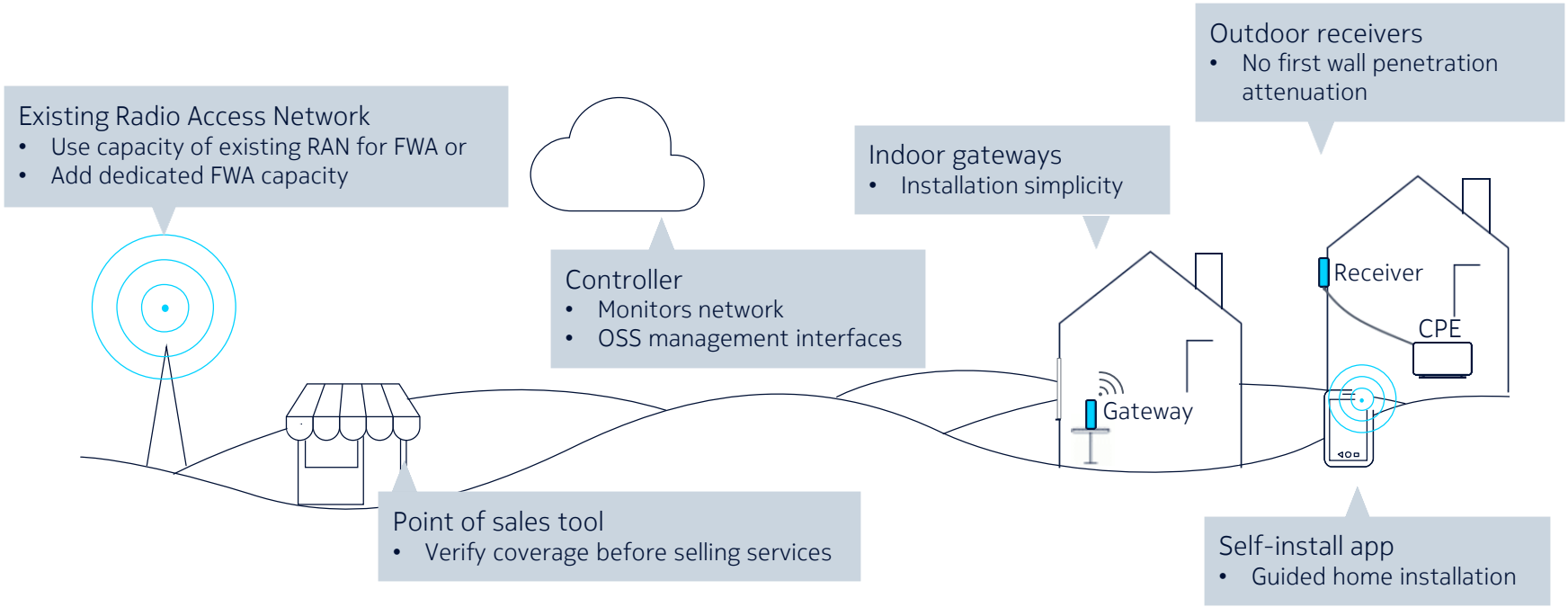
Nokia Digital Automation Cloud

An end-to-end digitalization platform for private wireless connectivity and automation.

NDAC comes with spectrum, Edge computer, access points, applications and user equipment.



Nokia FastMile – Enabling Fixed Wireless Access



Spectrum Options for Private LTE/5G in USA

Shared spectrum (CBRS) – B48 (3550-3700 MHz)

General Authorized Access (GAA), Free, Subject to Incumbents
Priority Access License PAL, Paid, Auction started July 23rd

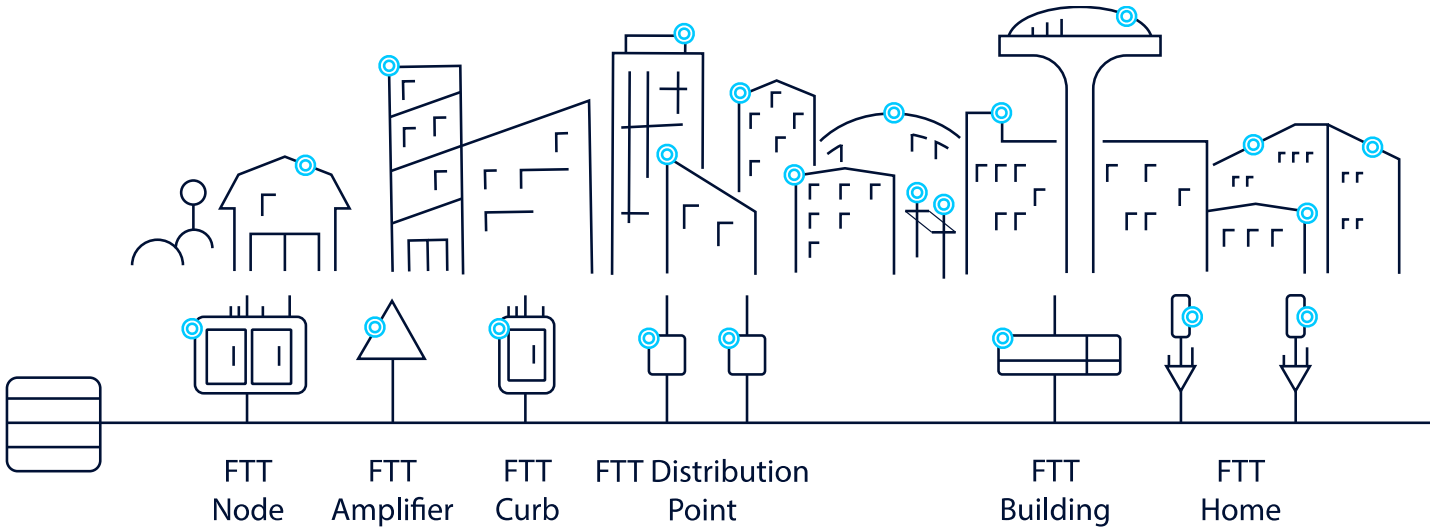
Partner Licensed Spectrum

B53 – Through Globalstar (Nokia is a preferred partner)
Spectrum partnering with CSPs

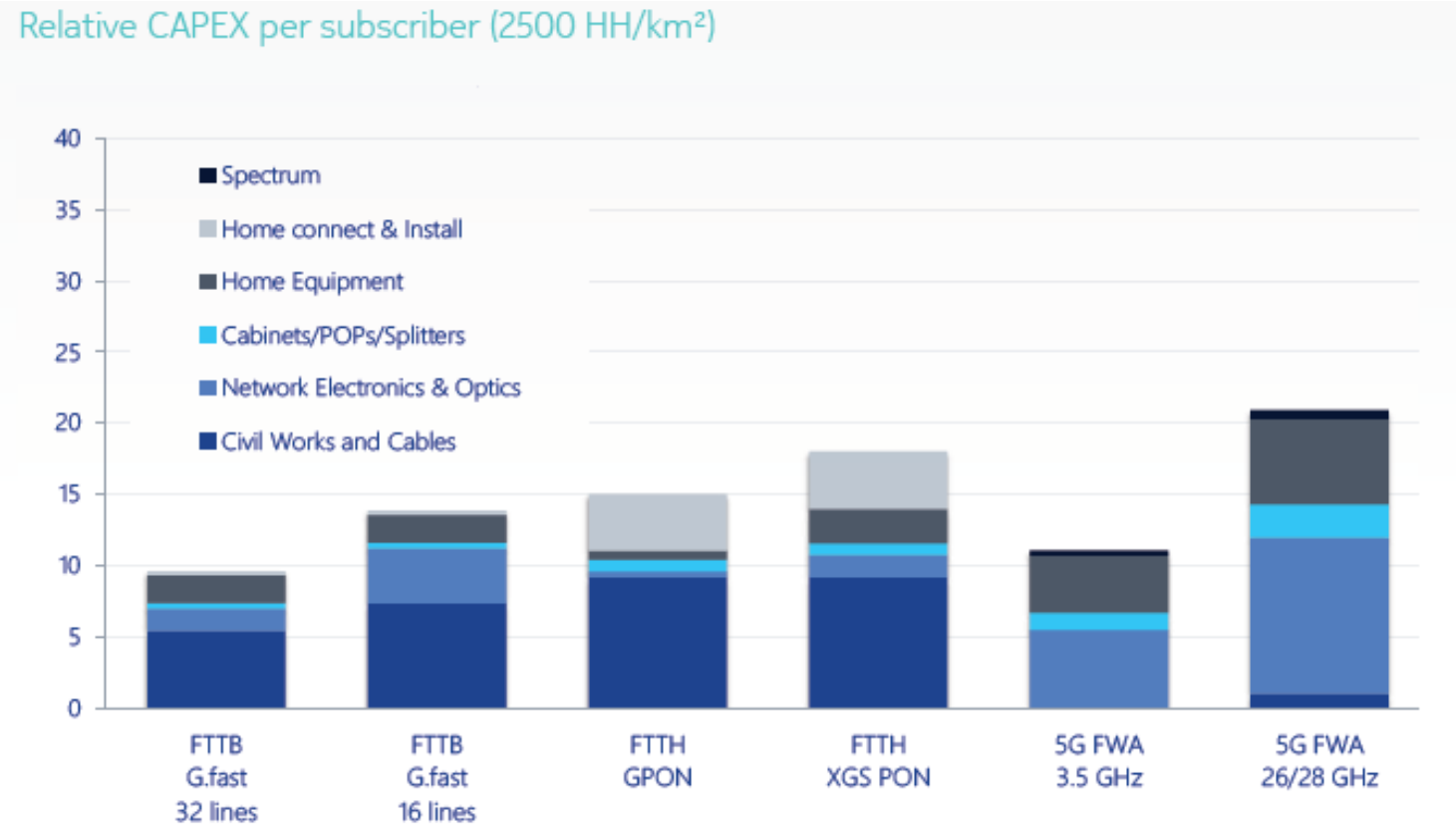
Unlicensed Spectrum Possibilities

USA
920 MHz
3.5 GHz
5 GHz
5.8 GHz
6 GHz
60 GHz

“Fiber to the most economical point”: The key to the business case



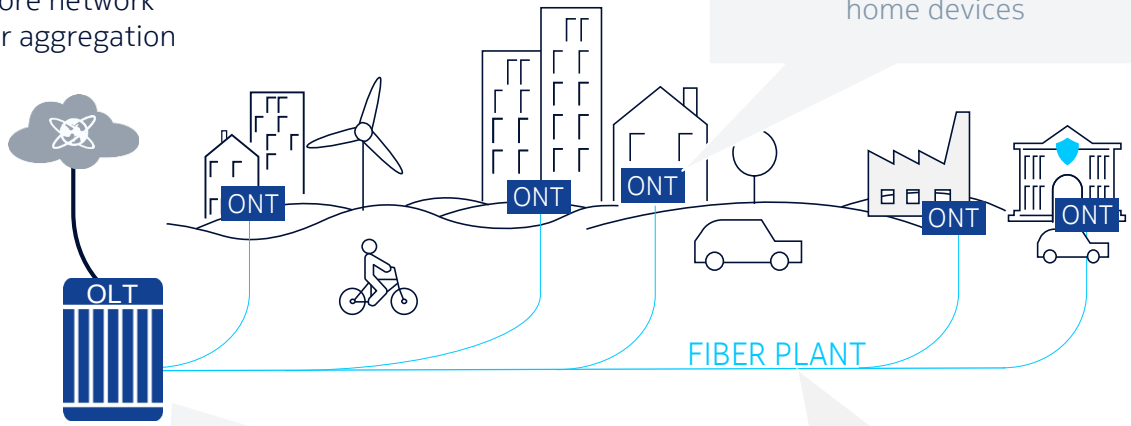
Source: Nokia Wired & Wireless Broadband E-book



Fiber to the home (FTTH) in a nutshell

UPLINK INTERFACE
core network
or aggregation

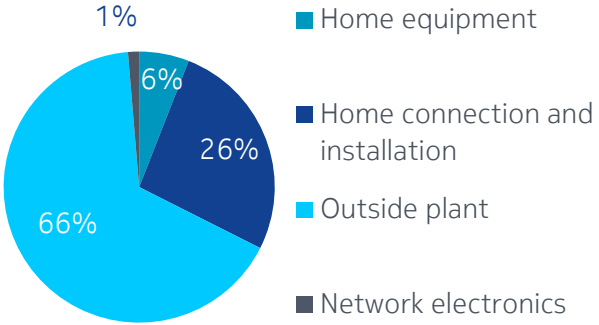
HOME SOLUTION
(Optical Network Termination)
terminates fiber and connects
home devices



ACCESS NODE
(Optical Line Termination)
aggregates traffic of multiple users and
connects them to the upper network

FIBER PLANT
Passive (low OPEX) and
future proof

FTTH cost breakdown



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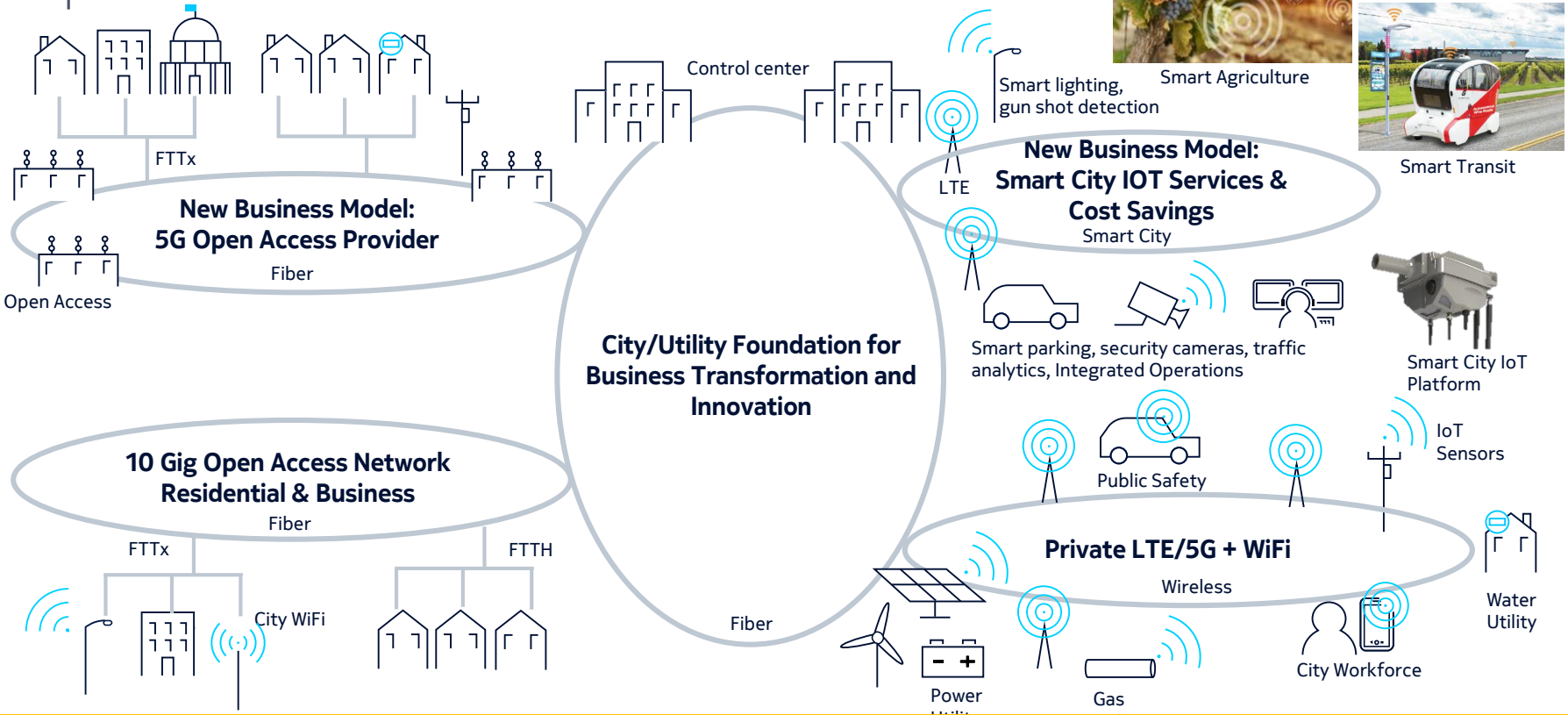
BUSINESS MODELS (PPP)

Smart City Utility

Disruptive Business Models



Unique value proposition for small to mid-size cities – enabled by Nokia/SCC

- **Context**: Many cities have strategic plans for broadband/Gig services and smart city/IoT initiatives. Small to mid-size cities typically face adoption barriers related to deep technical "know-how", funding & monetization, and program management for execution of such complex projects.

- **Solution:** Fully funded, and managed turnkey solution through industry leading team – Nokia (telecom infrastructure and services), and Smart City Capital (leader in smart city funding and monetization), in collaboration with the City through a Public-Private-Partnership (P3). Build, Operate, Finance/Monetize, and Transfer solution with flexibility to align with City priorities.

- **Benefits**:
  - Global smart city, broadband and P3 experience through industry leading team.
  - Delivered at little or $0 cost to the City.
  - Creates budget for the city by leveraging multiple revenue and cost savings sources, such as broadband services, FTTH/B, small cell, neutral host, energy savings, fleet/transport, smart parking, smart building, data/IoT monetization.
  - Long-term, flexible collaboration – 20 years concession to align with City's strategic priorities.
  - Flexible funding model to align with City's goals.
  - City retains oversight and control over P3's priorities in alignment with it's strategic plans.
  - Risk mitigation – technology, execution, and funding risks mitigated.

NOKIA SMART CITY CAPITAL

Infrastructure Industry: **CONTEXT (CITY)**

- Cities need Smart Technology to Interconnect Infrastructure
- Enables & Accelerates:
  - Industry (ex. Smart Manufacturing, Smart Agriculture)
  - Education & Innovation
  - Citizen Experience *(Health & Homes)*
  - Smart City Services
- Require a Smart City Utility to unlock economic value & benefits

Infrastructure Industry: **CONTEXT (CITIZEN)**

CONNECTIVITY FOR ALL

- High-speed communications for all will soon be a necessity, not a privilege

MUNICIPALITIES CAN EXPECT

- Ways to leverage the benefits of the digital age
- Faster, more efficient, smarter delivery of engineering & construction services
- Problems being solved faster, better (higher quality), and more efficiently than ever before
- Ability to optimize operations, drive efficiencies, and extend asset life
- Public sector involvement to stimulate public sector infrastructure delivery

A SMART CITY UTILTY ENABLES CONNECTIVITY FOR ALL CITIZENS

Smart City Utility: **BENEFITS**

- A complete and comprehensive **COMMUNICATIONS NETWORK** as a foundation
- **ECONOMIC GROWTH** with equitable access to connectivity, education, industry, clean water, efficient energy, and transportation
- **ENHANCED QUALITY OF LIFE,** range of amenities, **MULTI-MODAL TRANSPORTATION**, power and other services that attract residents, businesses and employers
- Assistance to first responders in locating, **MITIGATING, AND PREVENTING SAFETY ISSUES**
- Technical solutions that help conserve resources, improve services, and **SAVE TAXPAYERS MONEY & UNLOCK NEW REVENUES**

Infrastructure Industry: TRUE PUBLIC-PRIVATE PARTNERSHIP MODEL

- Design Build Finance Operate Maintain + <u>Monetize Transfer</u>
- Private partner covers some or all costs
- Private partner generates revenue from:
  - Neutral host – Create a Neutral Smart City Utility
  - Operational savings – Cost sharing of realized operational cost savings
  - Monetization of big data
- Minimal risks for municipalities in a fully de-risked scenario
- Private partner assumes business risk

SCC's Unique Value Proposition

FOCUS

ELIMINATING TOP ADOPTION BARRIERS:

- ✓ KNOWHOW (ADVISORY TO EXECUTION)
- ✓ VARIABLE RISK FUNDING & MONETIZATION
- ✓ SUPPORTS ENTIRE PROJECT NEED / AGGREGATION

PROVIDES

- GLOBAL P3 & SMART CITY EXPERIENCE
- KEY POLICY AND IMPLEMENTATION REQUIREMENTS
- ROADMAP DEVELOPMENT & EXECUTION

TURNKEY

- INTEGRATION
- FUNDING
- MONETIZATION
- CONSORTIUM

STRENGTH

- INDUSTRY LEADING TEAM, ELIMINATES LEARNING CURVE
- DELIVERED AT LITTLE OR $0 COST

REVENUE

LEVERAGING, MULTIPLE REVENUE SOURCES:

- NEUTRAL HOST
- BIG DATA ANALYTICS
- IOT MONETIZATION

Creates Budget

UNIQUELY QUALIFIED TO DELIVER NEXT GENERATION SMART, SAFE AND SUSTAINABLE INFRASTRUCTURE, **FOCUSED ON ELIMINATING ADOPTION BARRIERS**

Summary Value Proposition

Smart City Utility

Outcome

- Deliver Differentiated, End To End Design, Build, Operate, Finance / Monetize and Transfer (DBOM/FT) Solution,
- Supporting Multi-Phases Projects 20+ Years (Aligns to Agency Priorities)
- Via Comprehensive Monetization Plan, Support (Fund / De-Risk) Entire Project, Including Technology Refresh

Smart City Utility

- Smart City Fiber Open Access
- Smart City Wireless Open Access
- Smart City Open Access

New Solutions

- Fiber-to-the-x
- 5G Open Access
- Smart City IoT Platform
- Smart City Applications
- City WiFi & Private LTE/5G
- Safety & Security
- Connected Staff
- Advertising
- Revenue Creation / Revenue Share + ESCO

Our Unique Funding Model

Delivers An Industry Leading, Smart City Business Solutions, Focused On Eliminating The Digital Divide Via An Effective Portfolio Approach, Not Just Home Passes.

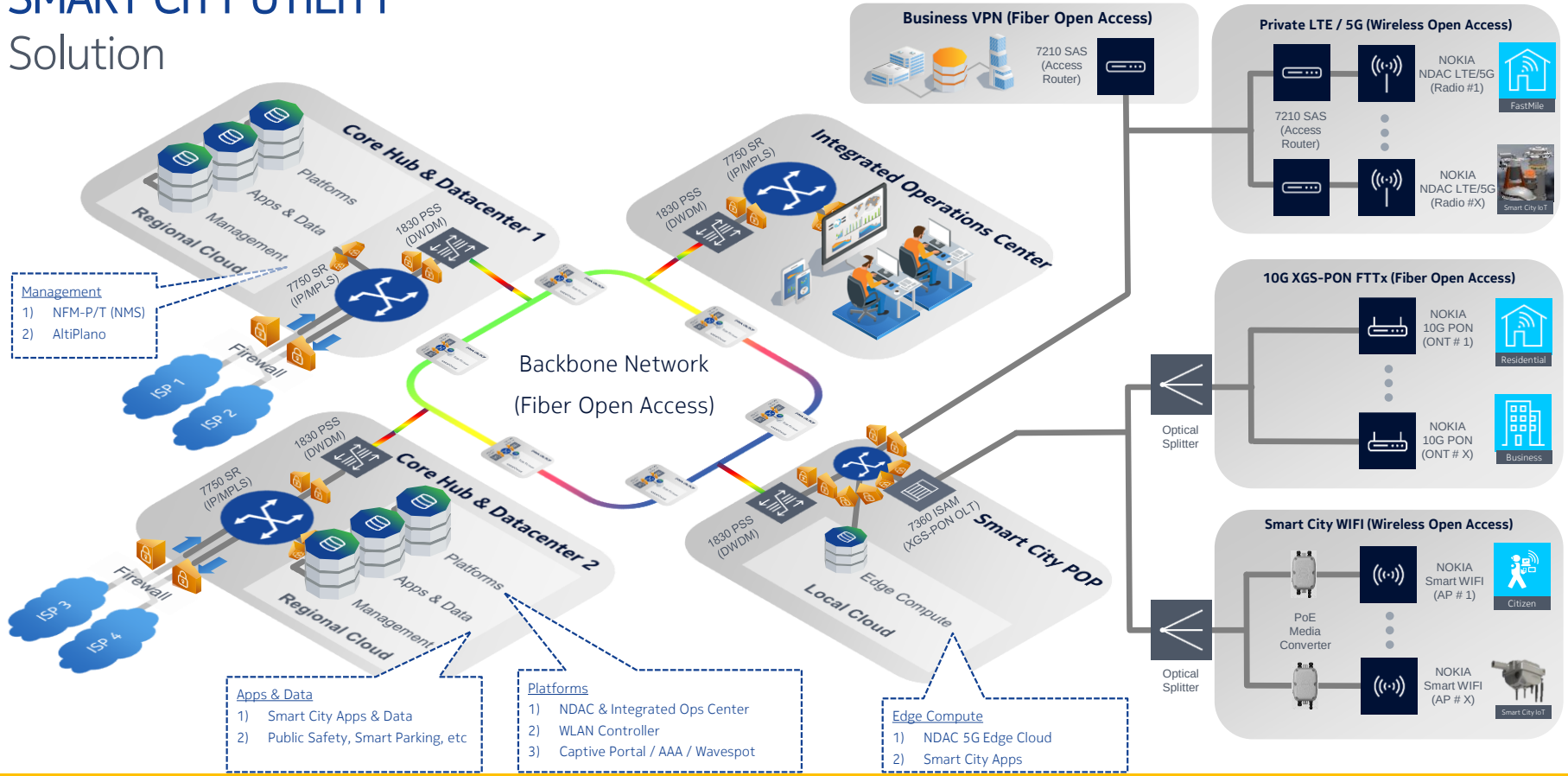
Combines Next Generation Outcome Based Model, Including Revenue Share, Savings Share, Structured Debt, Via Matched Funding (Senior And Equity).

Features:

- **Supports Entire Project**, True Build, Operate, Finance and Transfer
- Project **Terms As Long As 20+** Years Allowed
- Leverages Multi-Tenant Broadband Revenue, Smart City Big Data Analytics Monetization, Out Of Home Advertising, Savings Share and Budget Neutral Capacity
- **Materially De-risks Project** And Funding Requirement For The City
- Allows **City To Retain Ownership** Of The Data
- Revenue Sharing Levels, Based on Actual Cash Flow And Revenue Achieved, Post Minimum Yield Targets

Note: All Final Values, Structures are provided for on an indicative, non-binding basis and are based on final terms, conditions and required approvals.

SMART CITY UTILITY
Solution



NOKIA JACOBS

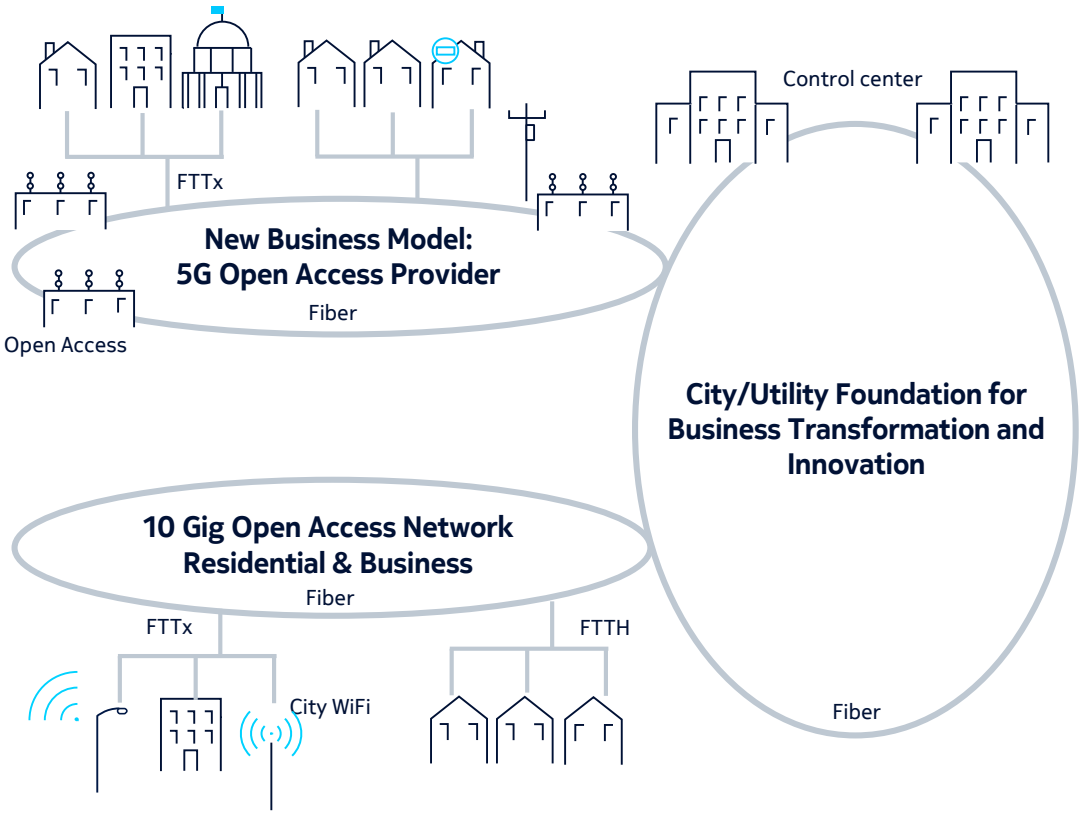
PHASE 1: FIBER OPEN ACCESS
10 Gig Open Access Network

Outcomes (Primary)

1. Connect Residents & Businesses with a NOKIA ULTRA-BROADBAND 10-Gig Fiber Open Access Platform.
2. Unlock new Revenue Streams, enhance the citizen experience & accelerate economy activity.

Outcomes (Secondary)

3. Foundation for Wireless Open Access Platform.
4. Foundation for Smart City Open Platform.



https://networks.nokia.com/solutions/ultra-broadband

PHASE 2: WIRELESS OPEN ACCESS

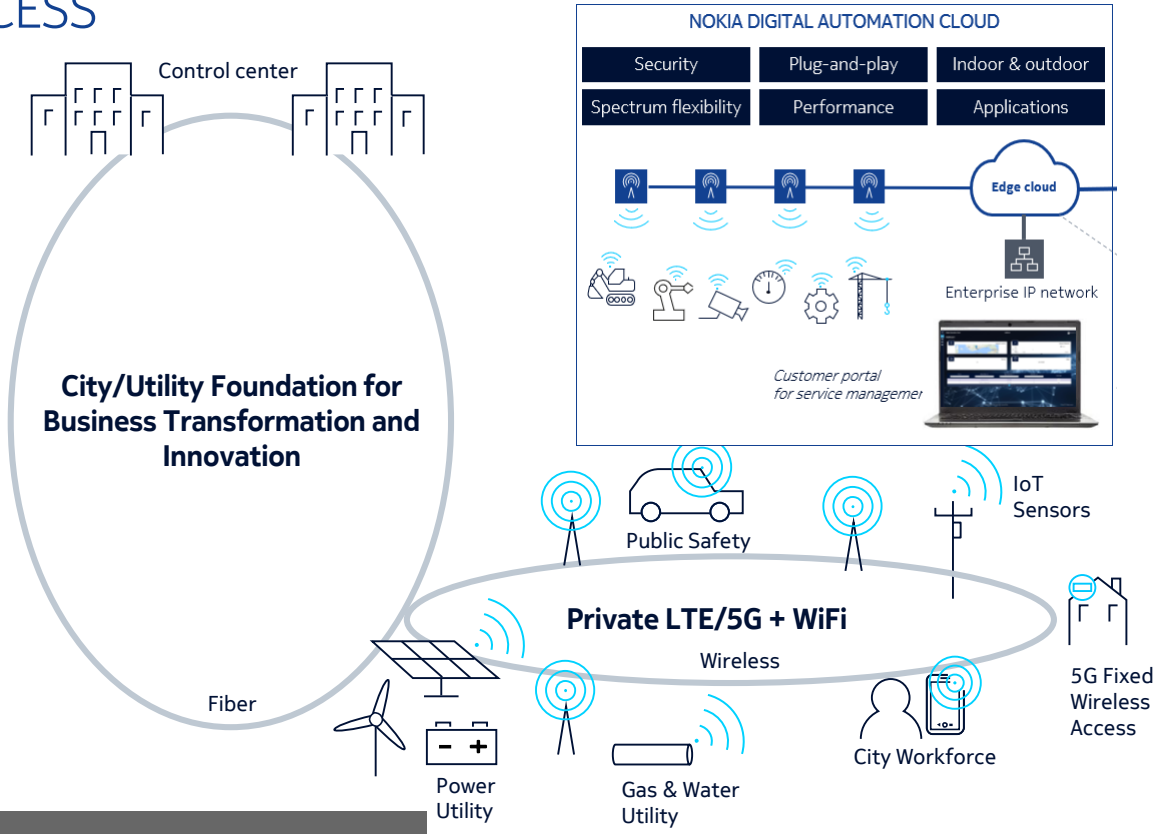
Private LTE & 5G + WiFi

Outcomes (Primary)

1. Connect citizens & city services with a NOKIA DIGITAL AUTOMATION CLOUD & NOKIA Smart WiFi. Wireless Access to every citizen, tourist, business, and Smart City IoT device.
2. Unlock new Revenue Streams, enhance the citizen/tourist experience & accelerate the economy.

Outcomes (Secondary)

3. Connect Smart City IoT devices ubiquitously across the city.
4. Foundation for Smart City Open Platform.



https://www.dac.nokia.com/

PHASE 3: SMART CITY OPEN ACCESS

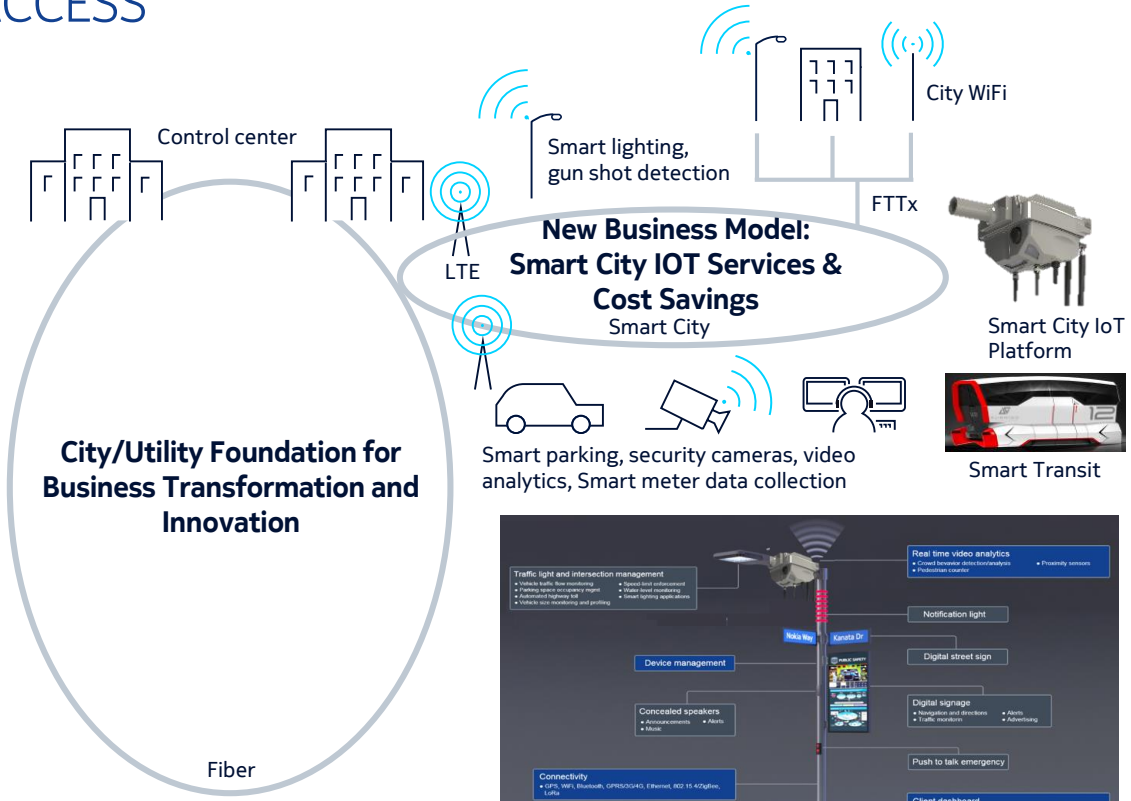
Smart City Platform + Apps

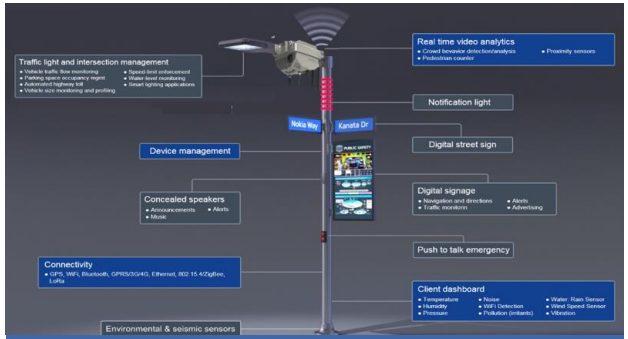
Outcomes (Primary)

1. Deliver a NOKIA SMART CITY Open Access & create a new ecosystem of Smart City services.
2. Unlock new Smart City Revenue Streams, enhance the citizen/tourist experience & accelerate the economy via local innovation.

Outcomes (Secondary)

3. Deliver a Smart City open platform API for the next generation of Smart City Applications.
4. Create World's first Smart Tourism Innovation Platform to create tomorrow's Smart Tourism companies (locally in CW-E)





Smart City Pole

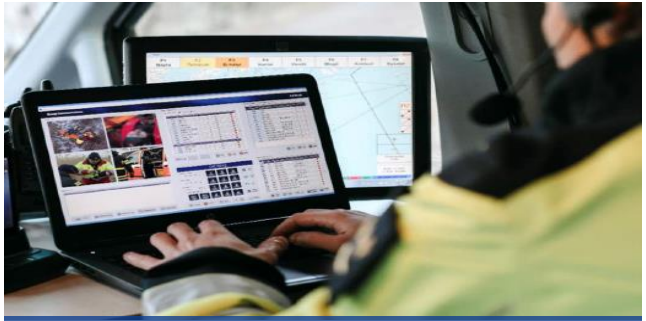
https://networks.nokia.com/industries/smart-city

NOKIA JACOBS SMART CITY CAPITAL

PHASE 3: SMART CITY OPEN ACCESS

Smart City Integration Operations Center

NOKIA Integrated Operations Center (IOC)



NOKIA IOC - Field Operations

NOKIA Drone Networks (NDN)

Fundamentals to Success

KNOW-HOW

- Leader in Technology (NOKIA)
- Leader in PMO & Engineering (JACOBS)
- Leader in Smart City Financing (SMART CITY CAPITAL)

FUNDING & MONETIZATION

- Private Equity (Budget Neutral & De-Risk up to 100%)
- Monetization (Unlock New Revenue Sources)
- Execution of Cost Savings Activities (Unlock Cost Savings)

PROVEN TECHNOLOGY

- Leader in Infrastructure Technology
- Open Platforms to Accelerate Innovation
- Built-in Technology Refresh

THE DIFFERENTIATOR

EXPERIENCE	• Global Leader in Information & Communication Technology (NOKIA) • Global Leader in PMO & Engineering (JACOBS) • Global Leader in Smart City Capital (SMART CITY CAPITAL)
OUTCOME-BASED MODELS	• Matching Smart City/IOT Adoption “Know How” to Monetization Models • Disruptive Short & Long Term Monetization Models
RISK MITIGATION	• Reduce Risk • Reduce Funding Requirements up to 100%
COMPLETE SOLUTION	• Technology, Program Management, & Services • Monetization solutions using Big Data Analytics, Advertising, etc
Ownership and Open	• City Owned and Open

NOKIA

Go Allwhere.

References

The Gigabit Smart City

Chattanooga – EPB (USA)

"Chattanooga is the perfect place for companies to enhance productivity today and test the applications everyone in the country will want tomorrow."

Harold DePriest, former CEO of EPB

GIG CITY™
CHATTANOOGA TN

Watch the video

Challenges/context

- Chattanooga was known as dirtiest city in the U.S. (you had to drive with your lights on during the day).
- In the early 2000's job opportunities were drying up in towns, and people were fleeing towns.
- To turn around its fortunes city decided to build the fastest internet in the United States and bet on digitization

Solution

- Chattanooga was the 1st to build a 1Gb network in 2010, and 1st to build 10 Gb network in 2015 (TWDM-PON).
- Nokia provided the Fiber access solution for both deployments
- The city built it through power supplier EPB.
- NG connect, works with EPB and the city to test new smart city concept.

Benefits

- It has attracted big international companies : Volkswagen, Amazon,…
- Creation of 2800 new jobs and a whole start-up community.
- Smart metering program allowed to reduce power outage by 60% and make estimated 312 M$ savings
- Digital signage trial: Live HD video streamed of the Aquarium at the Airport increase number of visitors (download case study).

NOKIA

Colorado – Ft. Collins offering Gig services using FTTH

Better than planned take rate

$59.95 for 1 Gig service

https://www.fcgov.com/connexion/residential-internet

Summary and Next Steps

- Nokia a Leader in Wired and Wireless Broadband
  - #1 in North America for fiber-to-the-home (FTTH) solutions
  - #1 globally for next-generation passive optical networks (NG-PON)
  - #1 in private wireless networks with 180 customers
  - 83 commercial 5G contracts. https://www.nokia.com/networks/5g/5g-in-action/
- Governments play a key role in addressing the digital divide
- Nokia Enterprise is assisting governments with broadband strategy/solutions
- Looking forward to supporting Arizona broadband initiatives.

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