RNC/QuakeCoRE Distributed Infrastructure

13th August2018

The Resiliency of Communication infrastructure during Alpine fault Earthquake scenarios in Westcoast, New Zealand

Draft Research Slides For Master Thesis

FARRUKH LATIF AND ANDREW AUSTIN

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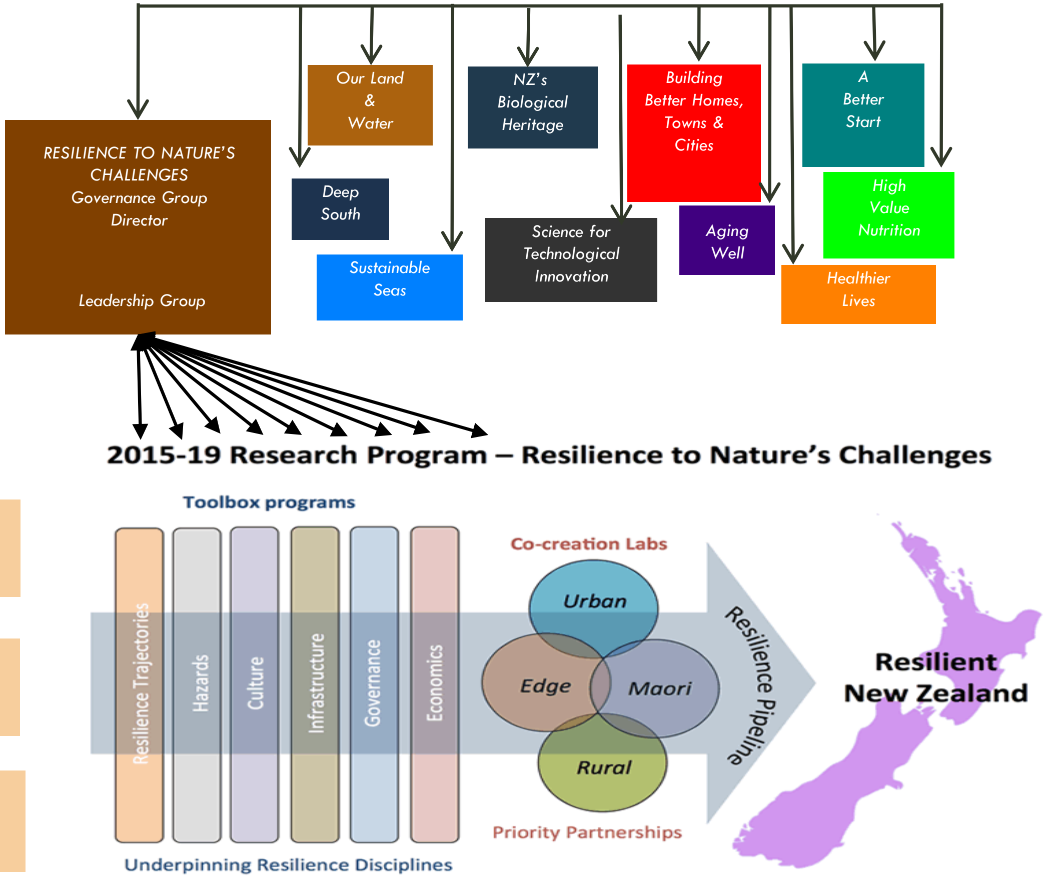
National SCIENCE Challenges

RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa – Ngā Ākina o Te Ao Tūroa

Ministry for business, innovation and employment national science challenges

infrastructure

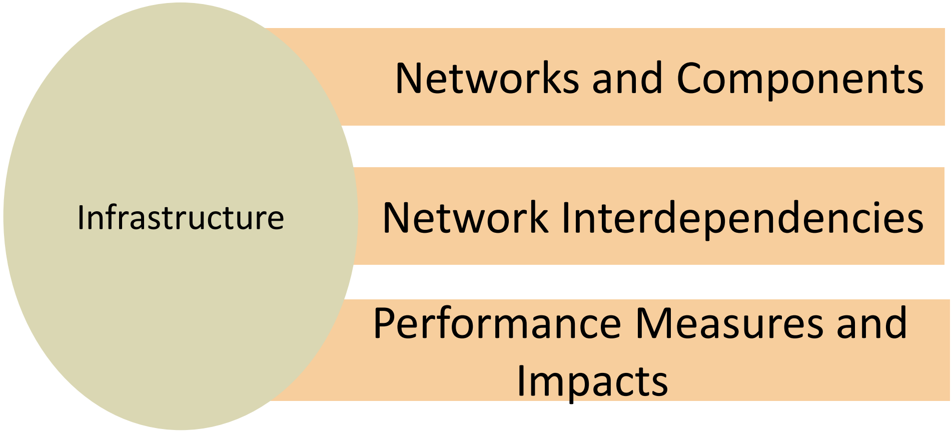


Contractual research funding relationship *between*
MBIE (contractor)
and
The research provider (research institutions)
through
GNS Science – RNC host (hosts the RNC director)

Sub-contractual research funding relationships

GNS (contractor) & lead research institutions;
⇅
Lead research institutions & Program members (research institutions)
⇅
Program members (research institutions) & researchers

RNC 1 Goals

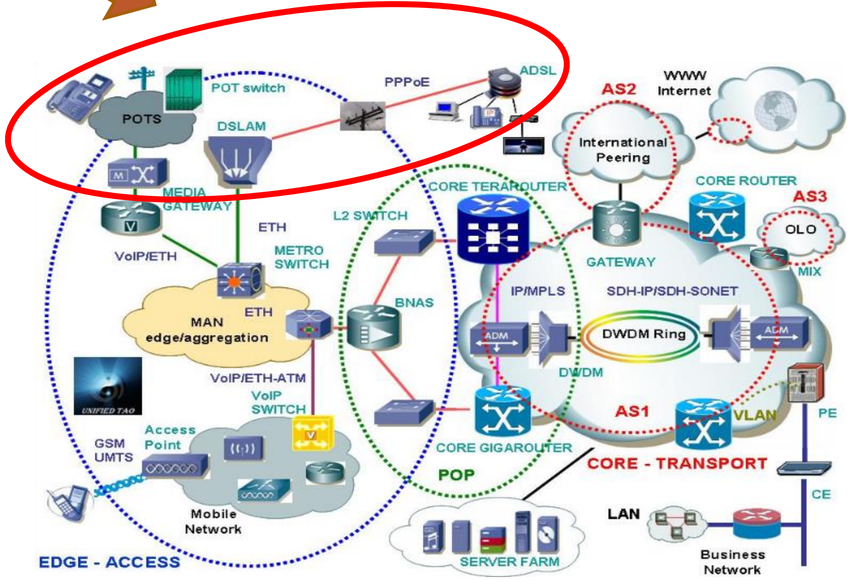


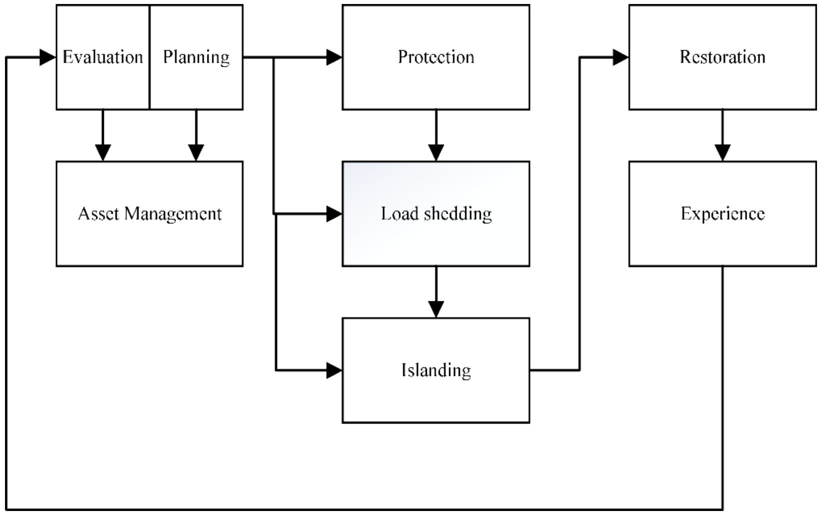
Electricity- Communication Lifeline Infrastructure Resilience

Electricity-Communication Resilience through West Coast Alpine Fault Scenario

Nirmal Nair (PI), Andrew Austin (AI), Samad Shirzadi (PhD), Duncan Maina (PhD), Yang Liu (Postdoc), Daniel Blake (Postdoc), Liam Wotherspoon (RNC DI, Lead)

Farrukh Latif(ME)





Reference [7]

"Electricity Network Assessment during Alpine Fault Event: microgrid as a solution for restoration" (Samad Shirzadi Deh Kohneh)

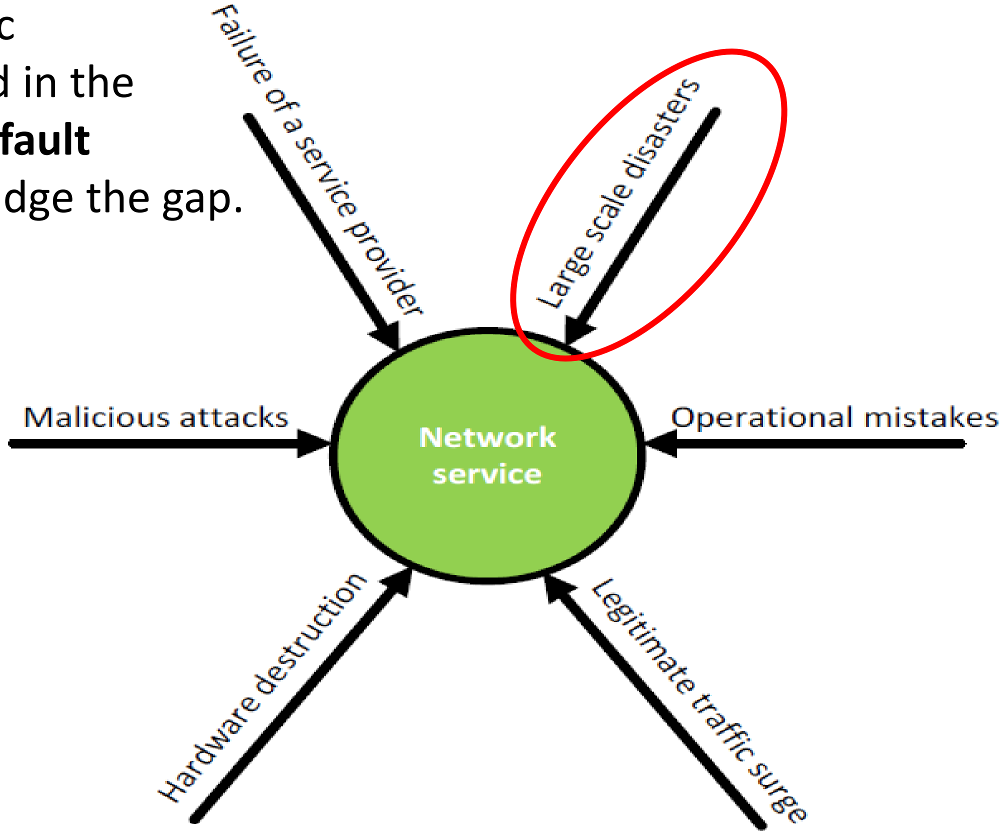
"Disaster related recovery of power networks" (Duncan Maina)

"Electric Power Distribution Systems Resilience Modelling Toolbox" (Leo Liu)

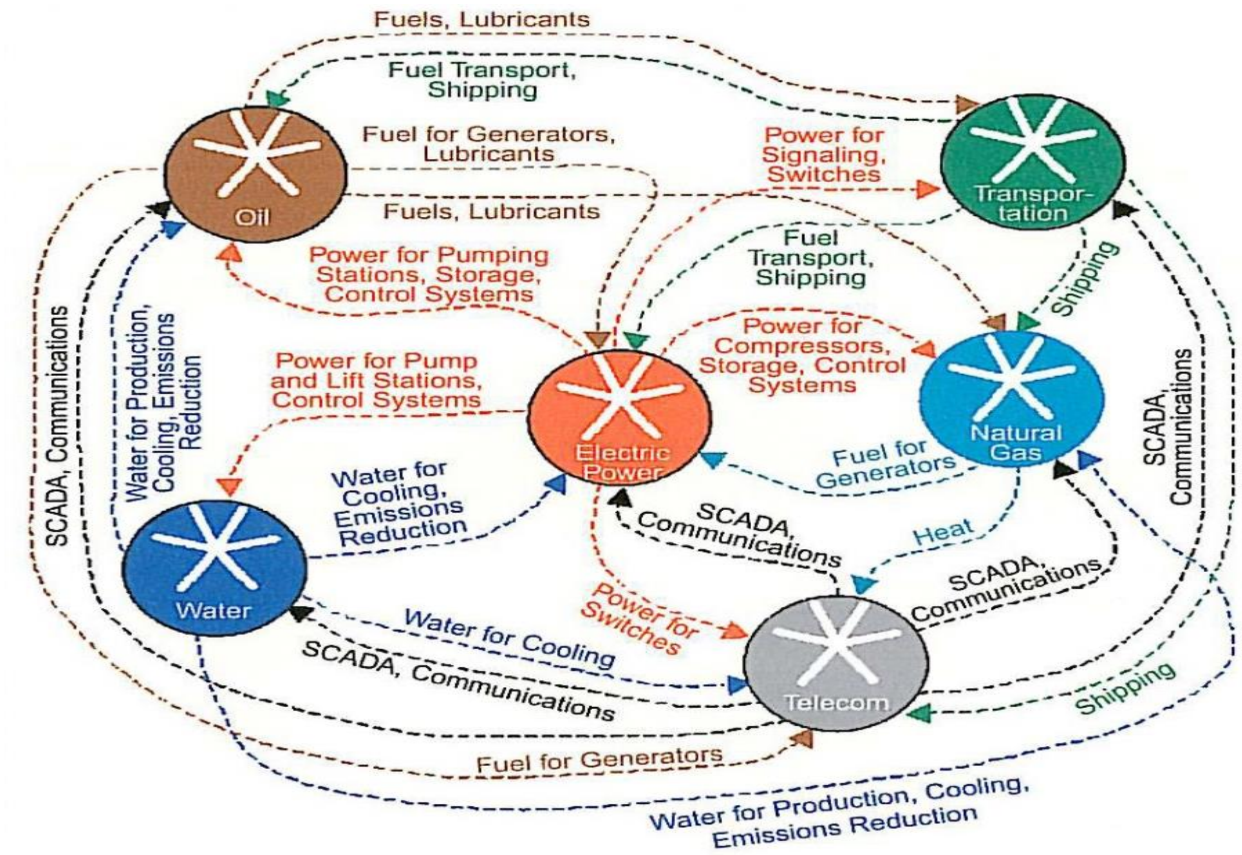
"Criticality Assessment and Asset Health management of electricity" (Ebad ur Rehram)

Motivation and Background

- In spite of the recognized critical importance, the assessment of the seismic performance for the telecommunication infrastructure is underrepresented in the literature. "**The Resiliency of Communication infrastructure during Alpine fault earthquake scenarios in Westcoast, New Zealand**" research project will bridge the gap.



Rationale: Why We Need Resiliency for Communication Network?



- The interdependency of other recovery mitigations (energy, transport etc.) on communications network is self-evident here.

(The key point here is – the reliance on communication technology is rapidly increasing and now the societies are highly dependent on technology than ever before).

Performance of Communication Lifeline During NZ Earthquakes in the Past

Kaikora Earthquake Damages(Courtesy of Chorus)

Research Objectives

This thesis will help to carry out the research on critical telecommunication infrastructure components **to understand and**:

RO1

Develop a seismic hazard model (using GIS tool) to quantify the risk to spatially distributed critical communication infrastructure and

i) Validate Against AF8 West Coast Scenarios

RO2

Develop a Measurement framework for Resilient communication infrastructure for seismic hazards

RO3

Guidelines for Future Resilient Communication Network Architecture

Resilience in Communication Lifeline

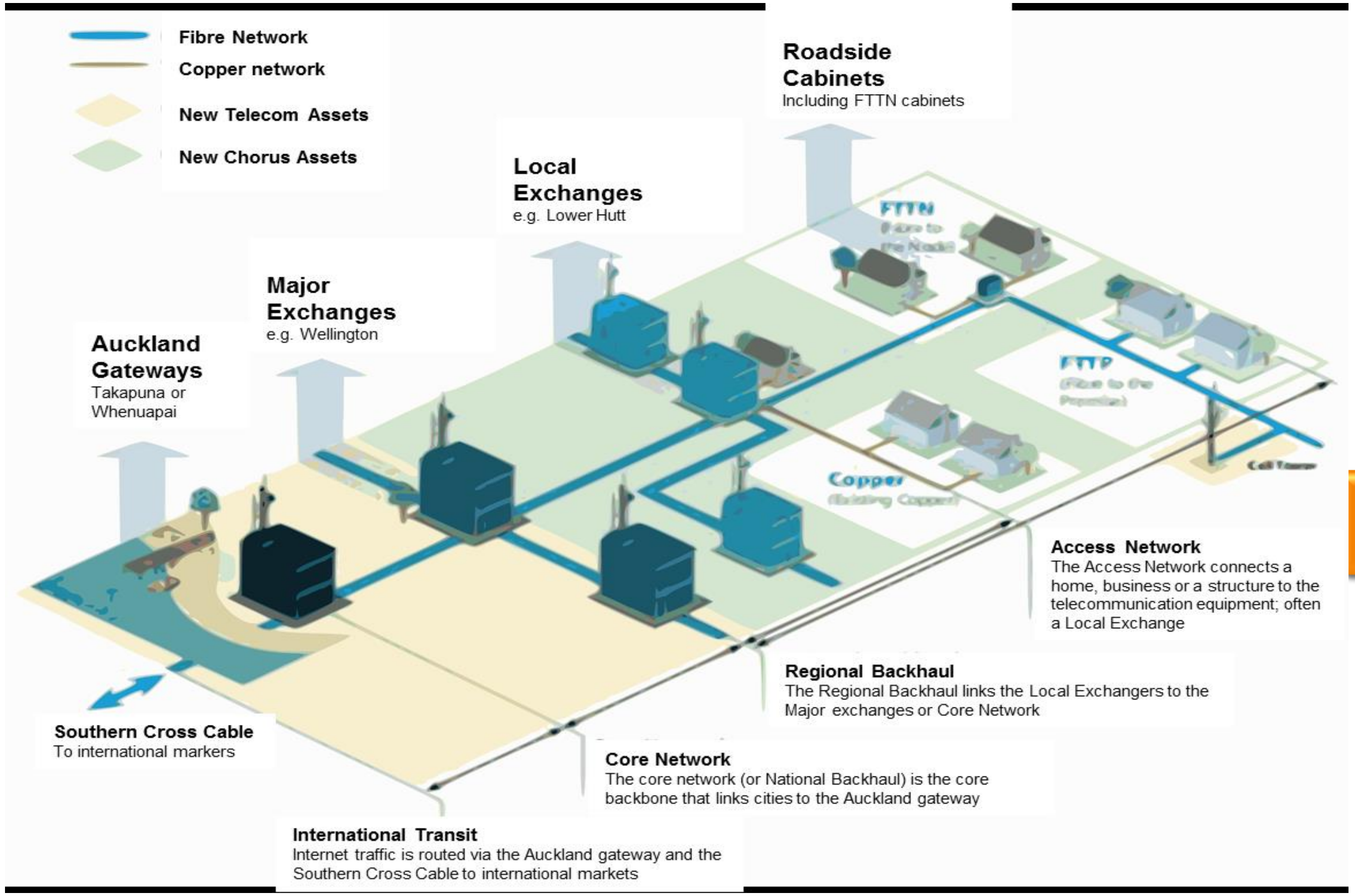
Ability of a Communication lifeline to withstand extraordinary and high impact-low probability events

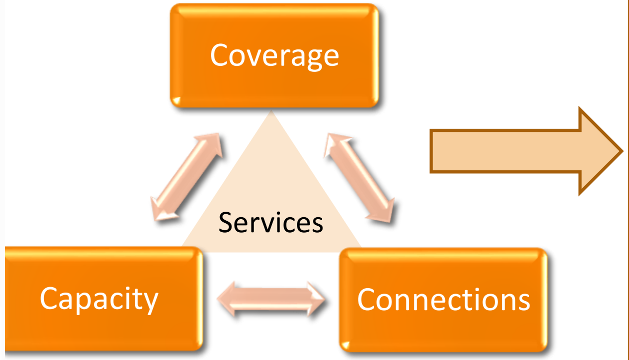
Key Features:

Robustness	• Keep operating or stay standing in the face of disaster • Withstand low-probability but high-consequence events
Resourcefulness	• Effectively manage a disaster as it unfolds • Identify options, prioritize what should be to control and mitigate the damage
Rapid Recovery	• Get things back to normal as fast as possible after a disaster • Contingency plans and emergency operations
Adaptability	• Absorb new lessons from a catastrophe • Introduce of new tools and technologies for boosting robustness, resourcefulness and recovery before the next crisis

Reference [2]

NZ Communication Infrastructure and Services

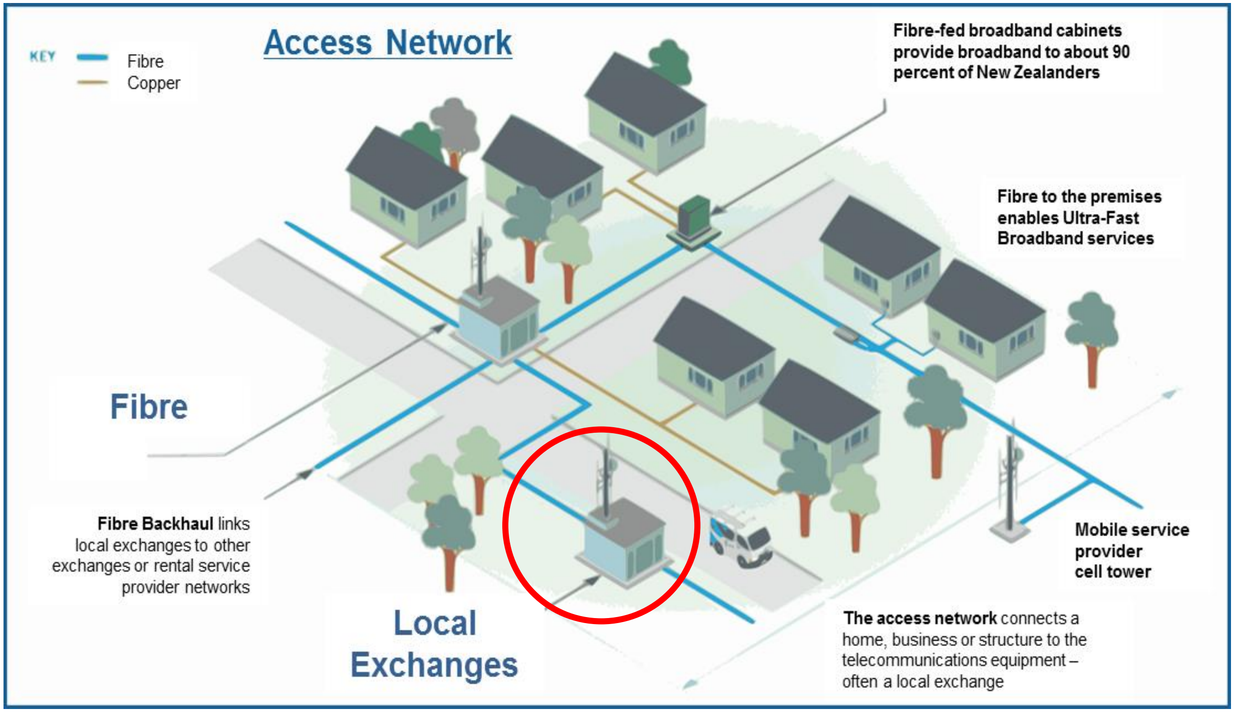


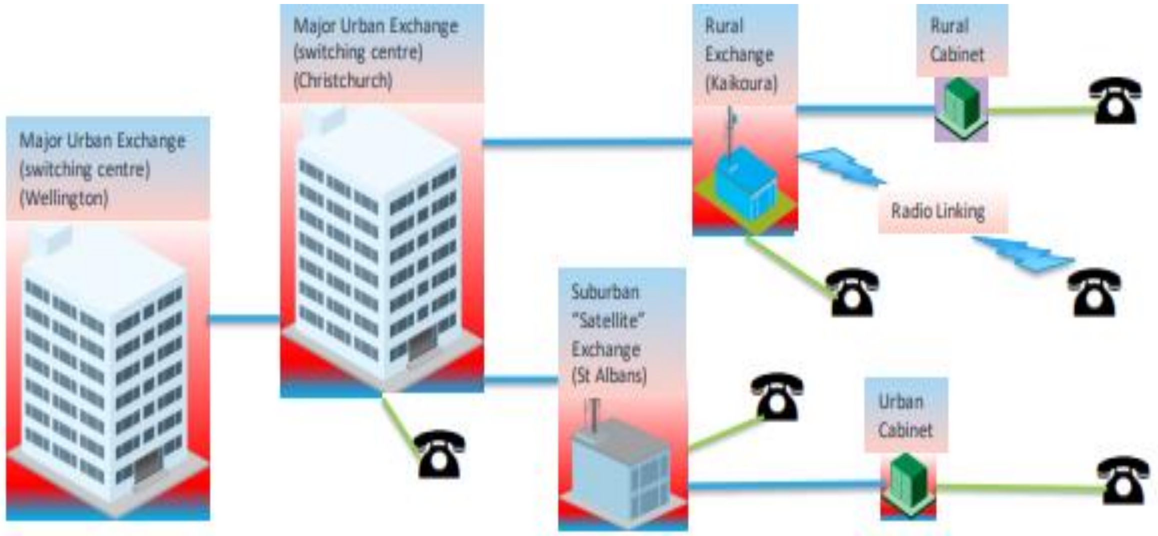


Broadband and Voice Network (Courtesy of Chorus)

- Voice
- Internet
- Cloud/Datacentres
- Enterprise Services
- Emergency Response Services
- Mission Critical Services
- Defence Services
- IOT
- VR
- AI
- TV/On Demand Content

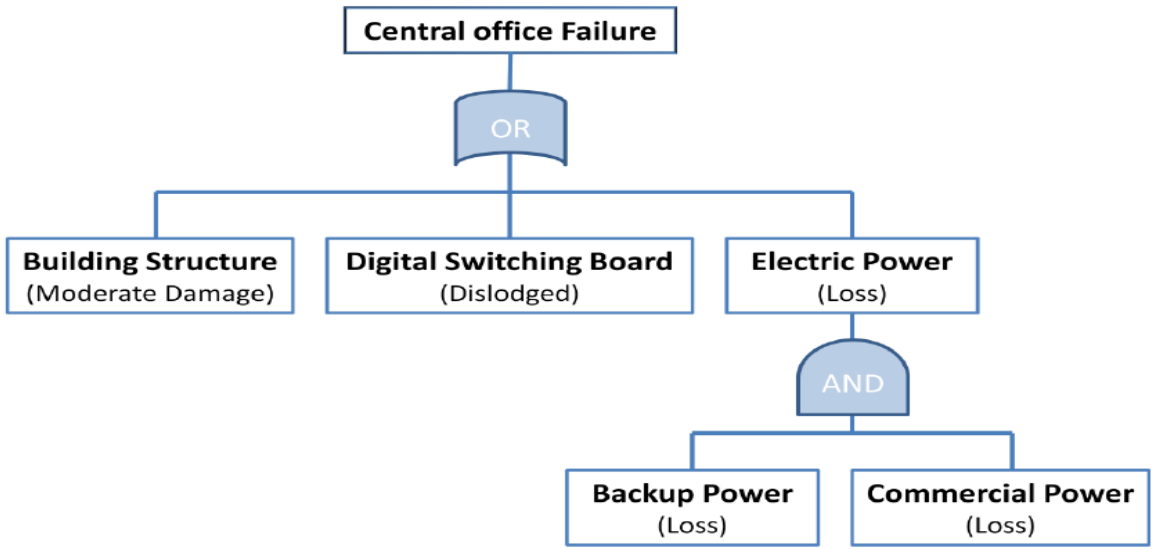
Communication Exchanges(CO) and Facilities: Critical Component For Service Delivery





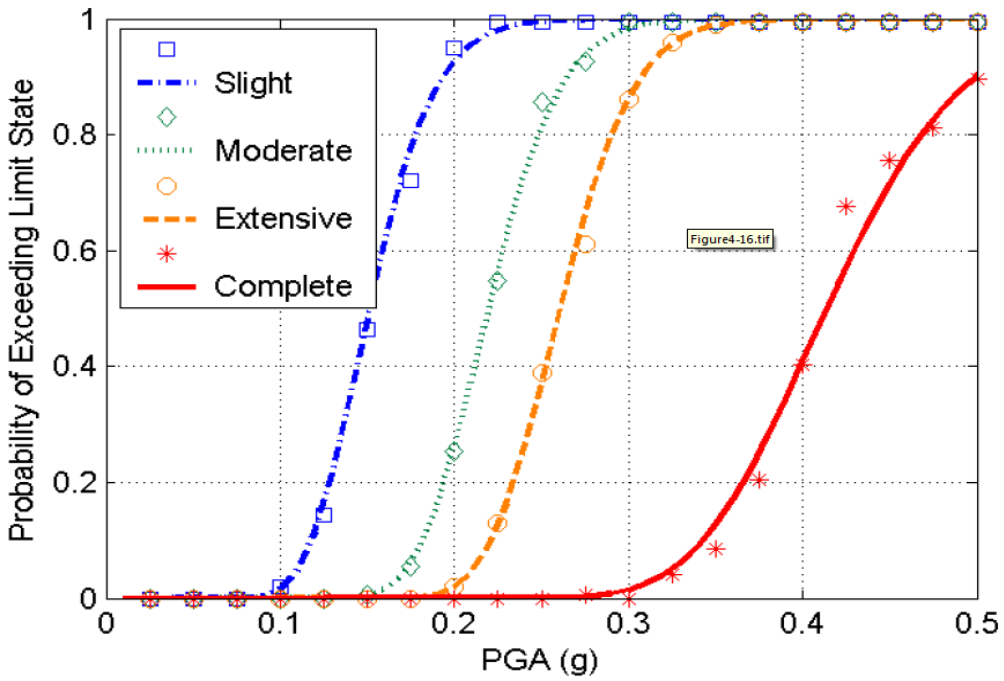
Fixed Network Architecture (Courtesy of Chorus)

Seismic Risk Quantification for Communication Infrastructure



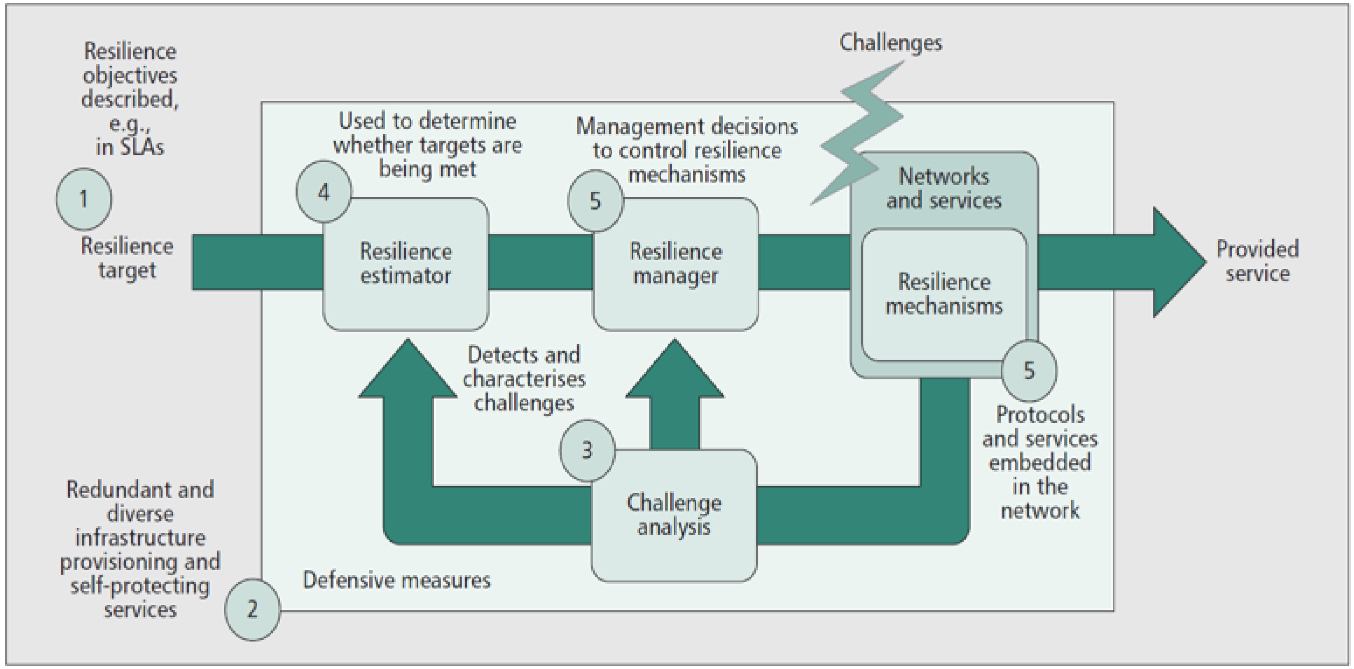
$$P(E_{CO}) = P\left(E_{Structure} \cup E_{Switching\_Board} \cup \left(E_{Backup} \cap E_{Commercial}\right)\right)$$

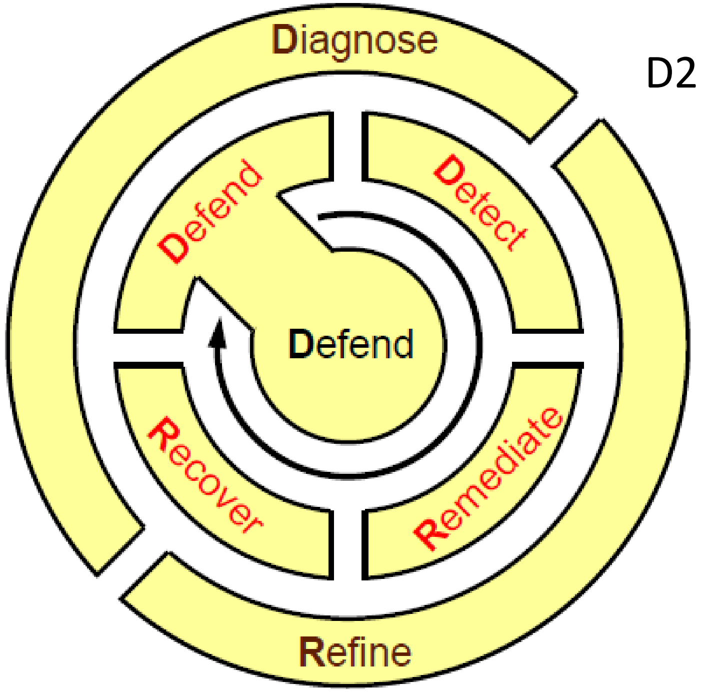
Reference [2]



Telecommunication Network Components	g	β
Point of Presence	0.40	0.60
Tandem Office	0.32	0.60
End Office	0.26	0.50

Resilience Strategy and Loopback Approach





D2R2 + DR

The Resilience control loop: derived from the real component of D2R2 + DR resilience strategy

Reference [6]

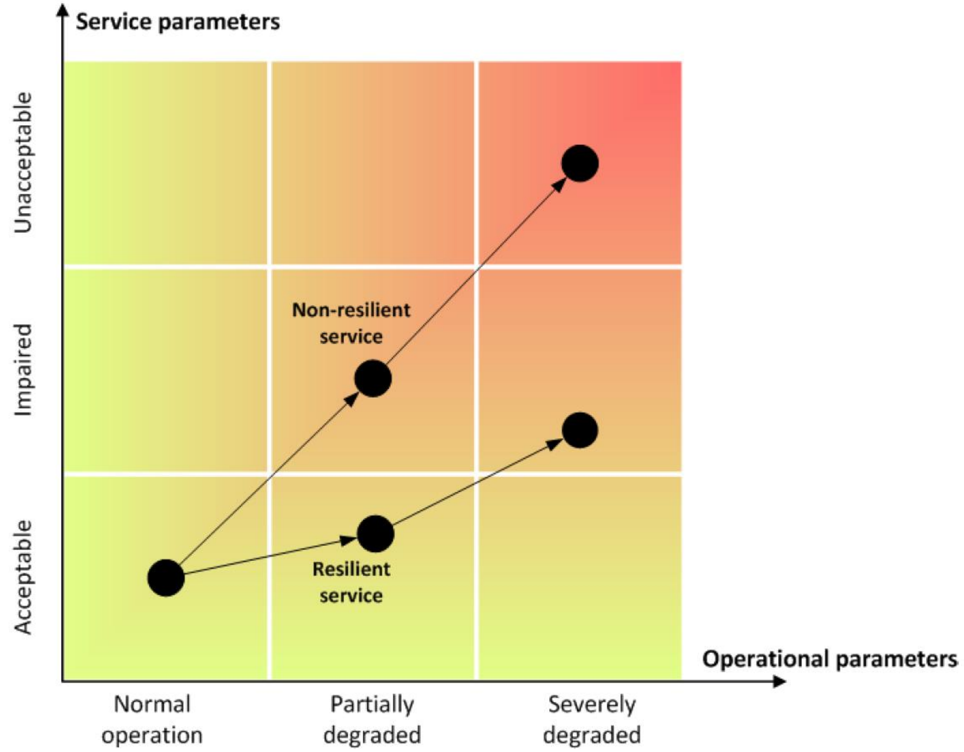
Reference [3]

RO2

Measurement Framework for Resilient Communication Lifeline

	Domain 1	Domain 2	Domain 3
Preparedness	Metric A		
Service Delivery	Metric B	Metric C	
Recovery			

Reference [5]

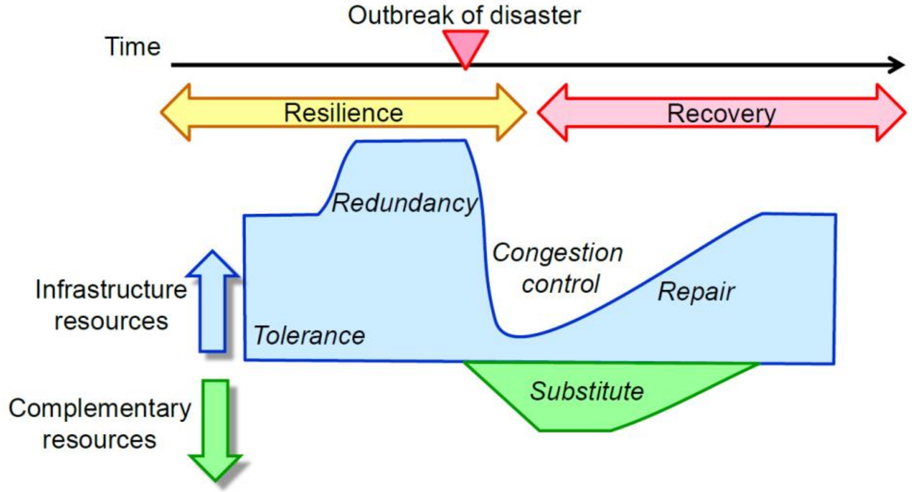


Resilient Vs. Non Resilient Service

RO3

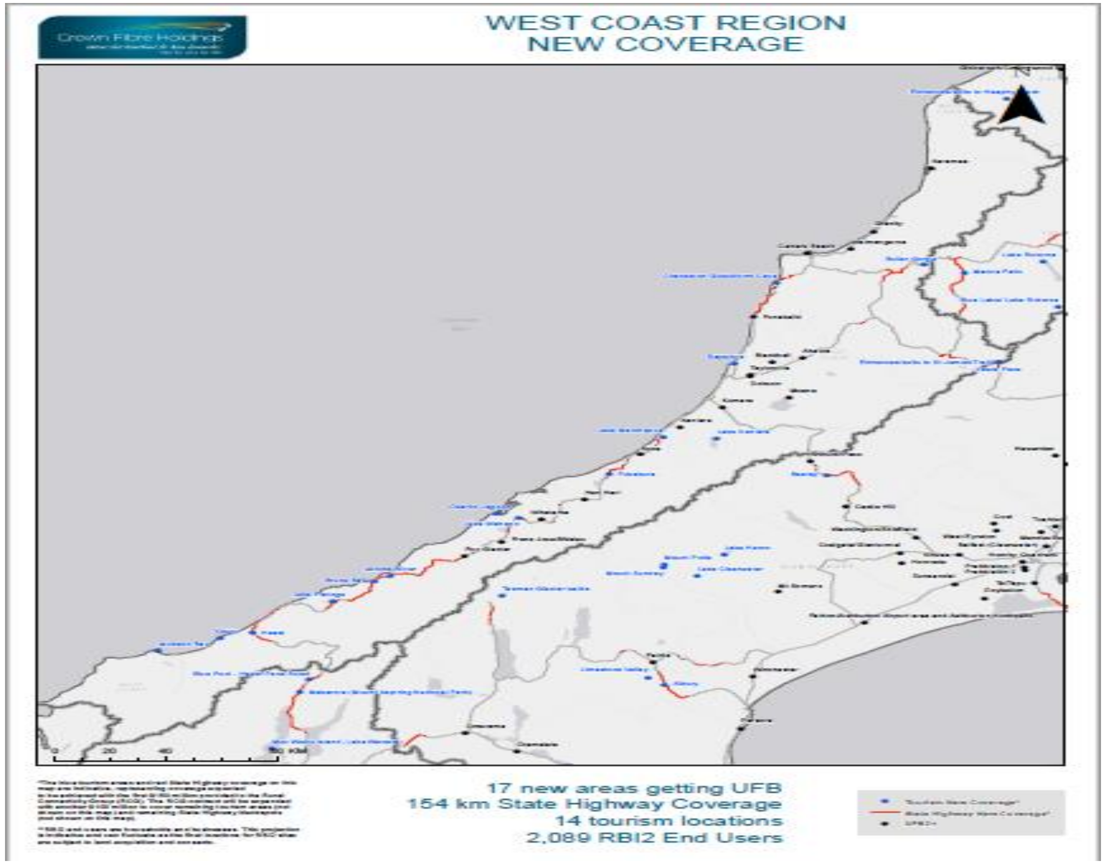
Time Phase of a Disaster and Resilient Communication Lifeline

Phase	Preparedness *before disaster*	Response and relief *at & during disaster*	Recovery and reconstruction *after disaster*
Disaster Relief Systems	Disaster detection	Emergency alert Evacuation assistance Safety Confirmation	Health care for victims
Network Resilience and Recovery	Highly reliable telecommunication network	Emergency telecommunication Telecommunication in disaster area Restoring damaged base stations Temporary telephone services Communication network for rehabilitation	
Electric Power Supply	Highly Reliable Power Supply Emergency generator and battery	Ensuring electric power supply including refueling method	



Reference [4 &5]

Use Case: West Coast AF8 Impact on Communication infrastructure



Crown Fibre Holdings

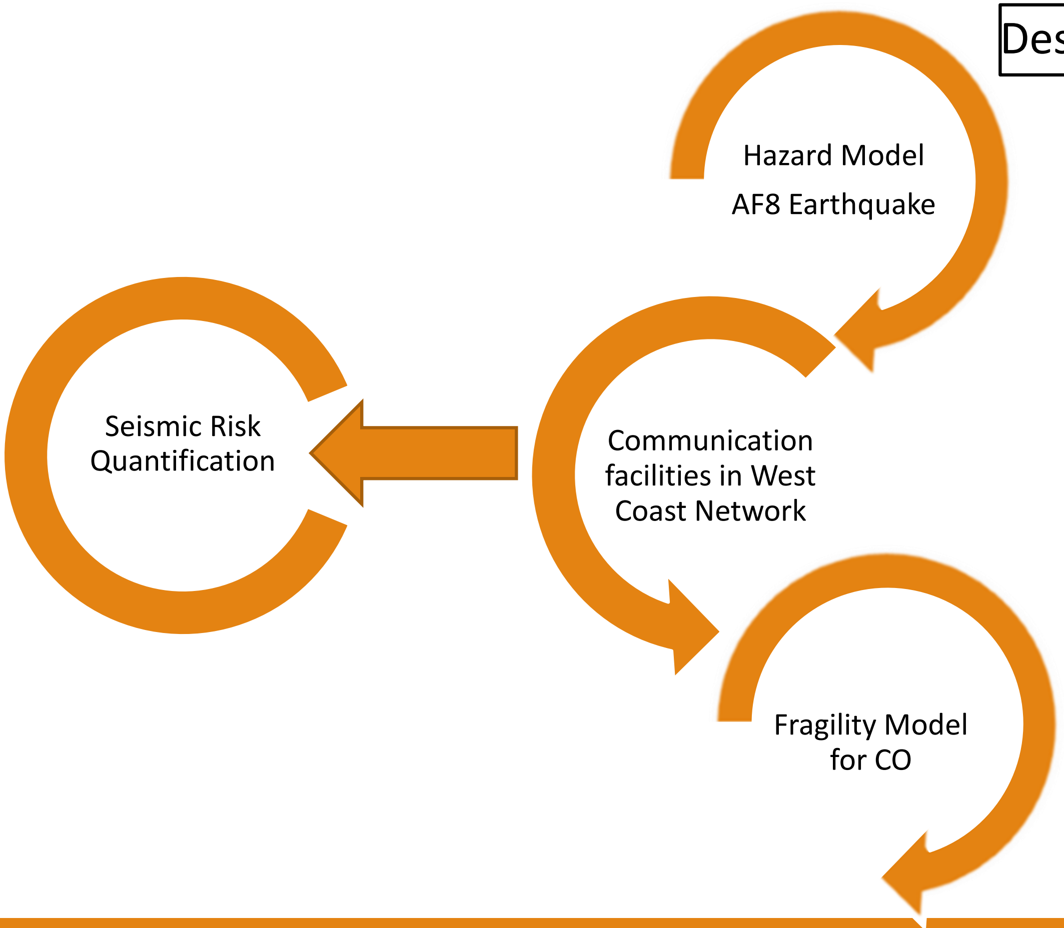
UFB coverage by region

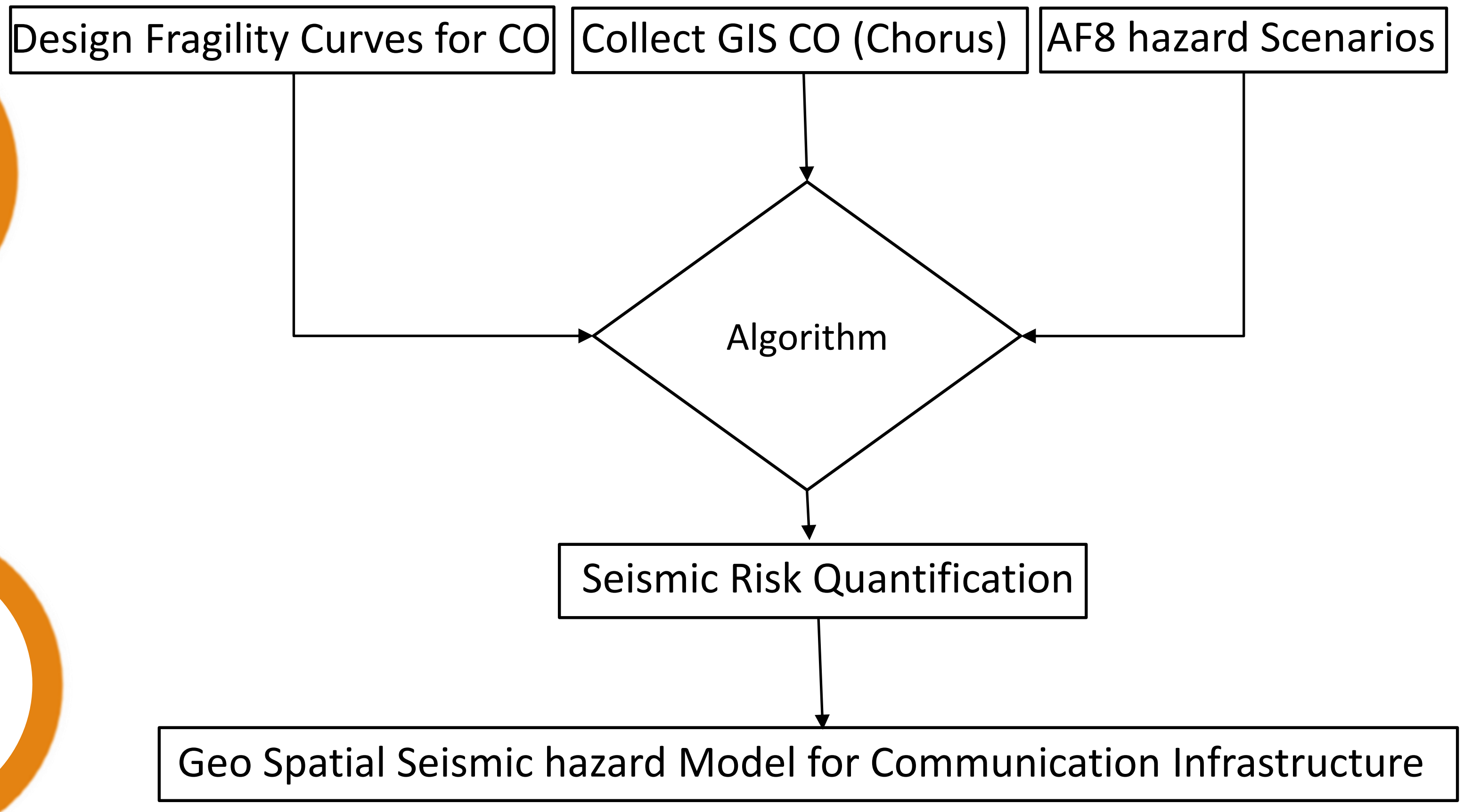
Region	UFB phases 1&2 premises	UFB phase 2+ premises	Total premises with UFB
Northland	39,558	5,547	45,105
Auckland	388,313	3,661	391,974
Waikato	134,253	14,668	148,921
Bay of Plenty	91,686	2,544	94,230
Gisborne	12,731	288	13,019
Taranaki	35,908	989	36,897
Hawke's Bay	47,447	1,597	49,044
Manawatu-Wanganui	75,928	4,634	80,562
Wellington	160,449	758	161,207
Nelson	23,784	3	23,787
Marlborough	14,919	678	15,597
Tasman	6,222	1,763	7,985
West Coast	8,565	2,678	11,243
Canterbury	192,115	8,699	200,814
Otago	73,491	7,380	80,871
Southland	26,638	4,336	30,974
Greenfields (To be built)	42,099	-	42,099
Total across regions	**1,374,107**	**60,222**	**1,434,329**

Note: the information in the above table is indicative only and subject to change. Crown Fibre Holdings will be working with partners to carry out more detailed planning over the coming months.

Reference [4]

Use Case: Approach





References

[1] – Leo A. Wrobel , and Sharon M. Wrobel, “Disaster Recovery Planning for Communications and Critical Infrastructure”, April 2009.

[2] – Kanoknart Leelardcharoen , “INTERDEPENDENT RESPONSE OF TELECOMMUNICATON AND ELECTRIC POWER SYSTEMS TO SEISMIC HAZARD ”, Georgia Institute of Technology, December 2011.

[3] – Abdul Jabbar, “A Framework to Quantify Network Resilience and Survivability”, 2010.

[4] – Blackmore P, “ Overview of Disaster Relief Systems, Network Resilience and Recovery”, in ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery , Version 1.0, May 2014.

[5] – “ Requirements for Network Resilience and Recovery ”, ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery , May 2014.

[6] –”Network Resilience: A systematic Approach”, IEEE Communication Magazine, July 2011.

[7] – Nair N, “Electricity Distribution Resilience Framework informed by West Coast Alpine Fault Scenario”, Distributed Infrastructure Toolbox: NSC-RNC Project, March 2018.

[8] “Measurement Frameworks and Metrics for Resilient Networks and Services: Technical report” in European Network and Information Security Agency, Feb 2011.

[8] – Rob Ruiter, Chorus Network Specialist and www.chorus.co.nz

[9] - https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Infrastructure/How-can-we-keep-the-lights-on-during-and-after-a-natural-disaster.

[10] - https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Infrastructure.

[11] - https://www.crowninfrastructure.govt.nz/ufb-initiative/