Preamble.

This presentation outlines the benefits of this active body of work for large OEMs, network equipment manufacturers, smart phone app developers, low cost/low power device manufactures, all of whom have a market share interest in "Massive IoT". I have contended this cannot be achieved without Nature's approach to "Chirp" messaging and how super-organisms (Ants, Bees) flourish. Blog post

My previous company, ACG, was contracted by the US Air Force and NIST to work on Supervised Autonomy for remote robots (telerobotics), see Technical Paper. When commercial radios became more affordable, ACG became Meshdynamics and we began work on robust real-time connectivity for remote military machines.

In 2002, SPAWAR/DARPA funded a multi-year NRE contract for us to develop a device/protocol agnostic mesh control layer for use on military gear- from tree-based mobile backhauls (802.11) to body area networks (802.15). We must also provide the transport for real time, terse, Non-IP "Stealth Chirps" securely over IP backbones. This Hybrid Mesh must provide time-sensitive bridging across both tree and non-tree sub networks, running proactive periodic "shuttle" services.

Rationale for "Chirp Networks".

Nature's messaging systems, like pollen, are Receiver-Oriented. It is openly published because only the intended subscribers (flowers) can decipher the code. Because it is so open, it is also lightweight and can use all available transports – e.g. wind, bees. But the message must reach recipient in spring or its useless. So Pollen floods the transports during Allergy season. Sender-oriented systems (IP) hate storms. And quasi-synchronous traffic is bothersome. More

As in Nature, digital versions of birds MUST "chirp" freely. "small data" flows are heard by all. And new events discovered : "the cat is now here". These digital versions also need "Big Data" supervisory loops- periodic north bound shuttles needed.

"Massive IoT" needs a "Natural" approach. Sender-based, IP transport are neither suitable nor scalable. ZDNet Podcast

The Journey.

Taking cues from Nature, this work began with trees connecting to edge networks using a common mesh control layer. We used VOIP to emulate "Chirps" – terse and periodic not favored by IP, and hence the need for timed transport.

In 2012 I started the blog to reflect an alternate approach to the IOT hype. Intel sponsored the book. It received the 2014 Dr. Dobbs Jolt Award. The book moves on from trees to terse messaging by pollen, bees, ants and birds – "chirp protocols" and the work flow automation within collaborative chirp family ecosystems.

The MeshSuite licensing includes patents covering essential facets of these emerging digital ant ecosystems and the machine control architectures they need. A deeper dive in features/benefits of MeshSuite licensing is here

My IP legal counsel is available to answer questions on issued patents listed here .

And, as always, your feedback and suggestions are welcomed. Thank you

Francis daCosta, Jan 2022 .

ZDNet Podcast HTML
ZDNet Podcast MP3

Natural Species Evolved Organically.

There was no centralized authority dispersing uniquely addressable MAC-IDs to trees or birds. Their signaling protocols evolved to address their changing worlds and interactions with other species. The messaging has organically grown to be receiver oriented- useful only to intended subscribers. No centralized standards were needed. While pollen blows freely, only flowers can recognize the "tune" and respond during allergy season.

In contrast the IP backbone is sender-oriented – the recipient MAC-ID is needed. It abhors broadcast storms. It is NOT designed to move terse "chirps" or repetitive "tunes" with deterministic latency of sensor-actuator control loops.

Nature is also open. Like pollen, all sounds/smells are operate in a public, shared domain. Symbiotic relationships form. All birds in my backyard tell the zone that my cat is out. My cat – if listening - also discovers that his stealth needs more work.

Chirp devices are Small, Dumb, Cheap, and Copious They will like ants and other super colonies, proliferate over time.

Our cloud servers need to communicate with these emergent purpose built species of devices – our digital ants. Blog

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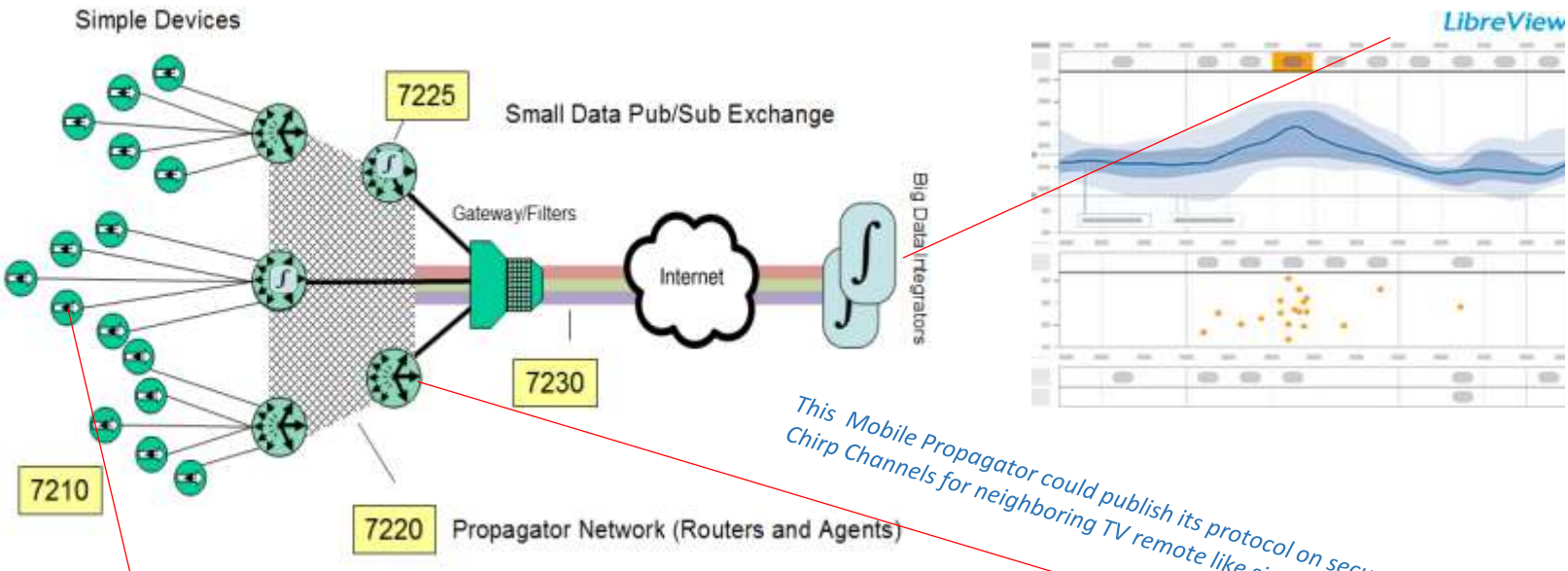
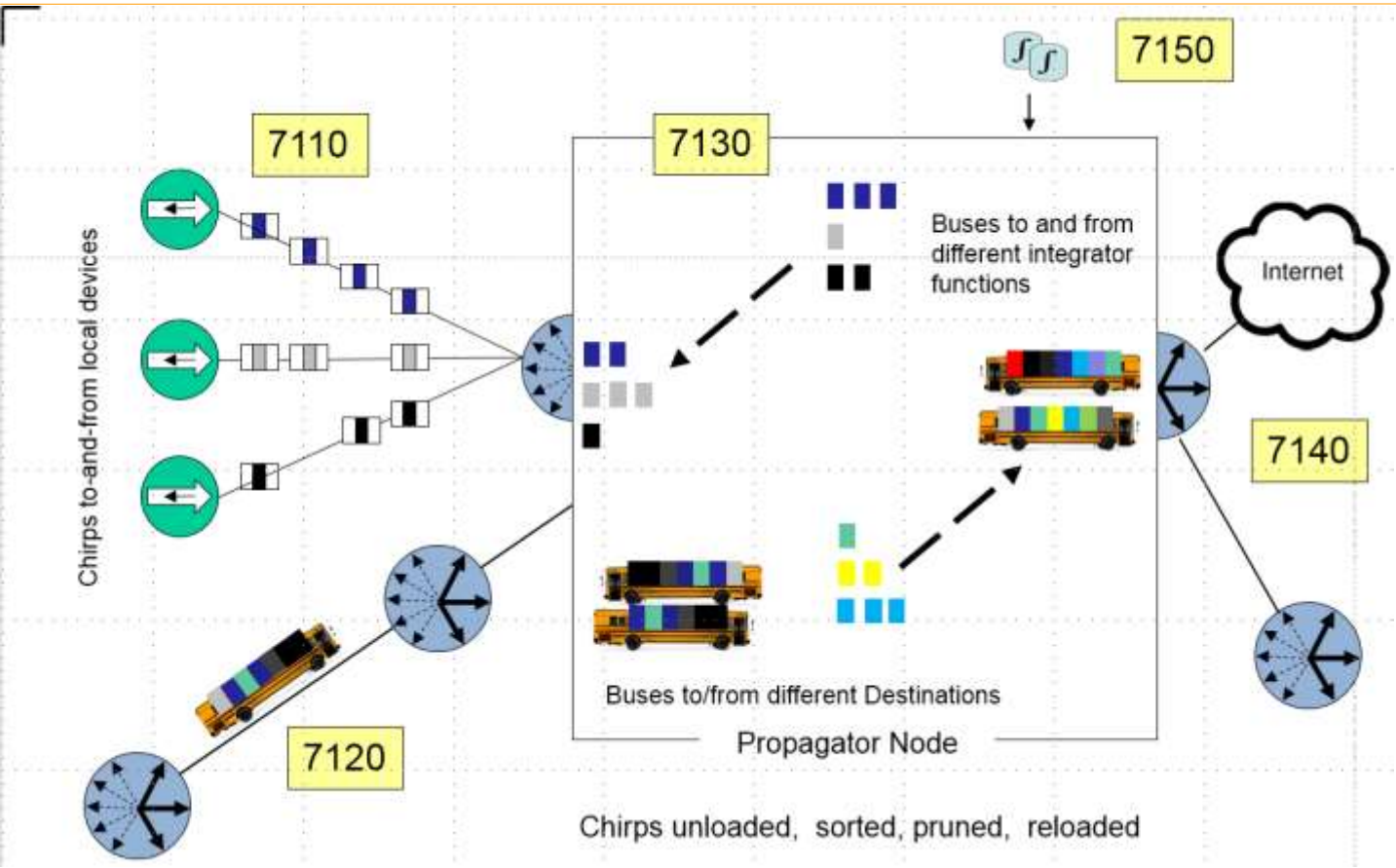
Here is an example of an existing "Chirp" device – the glucose monitoring system. Its Chirps are picked up by a mobile reader. The reader periodically docks with a computer and the history is transported to the cloud app (LibreView).

A 3 tiered architecture is proposed for "Massive IoT". The simple pollen like chirp devices, when activated, transmit a tune that the "mother" device registers as the "MAC-ID". Using apps, the mother connects to the Big Data to provide a sensor update. The pollen is spent in 14 days. The mother and new chirp device exchange new tunes and the cycle repeats.





Birds recognize their mother's Chirp and respond to it. Over time their tune vocabulary adds other signals to which they respond as deterministic finite automata to an expanding and dynamic physical environment.

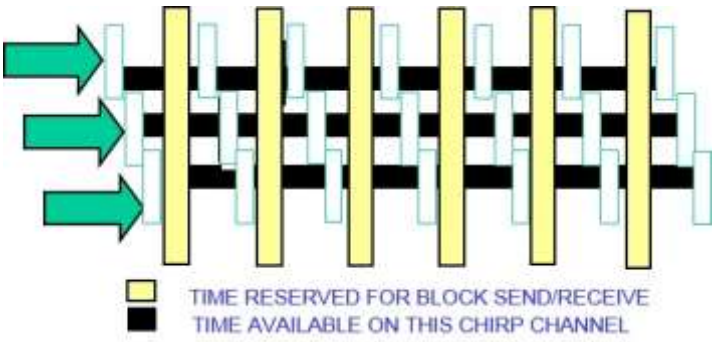
Our digital versions of ant, pollen and terse messaging requires timed shuttle buses to drive the machine control loops. This shuttle bus must run from the propagators (mothers) over the IP best-efforts backbone to provide the Mission level directives from Houston to the execution control layer on the Mars Rover.: the dual control loop.

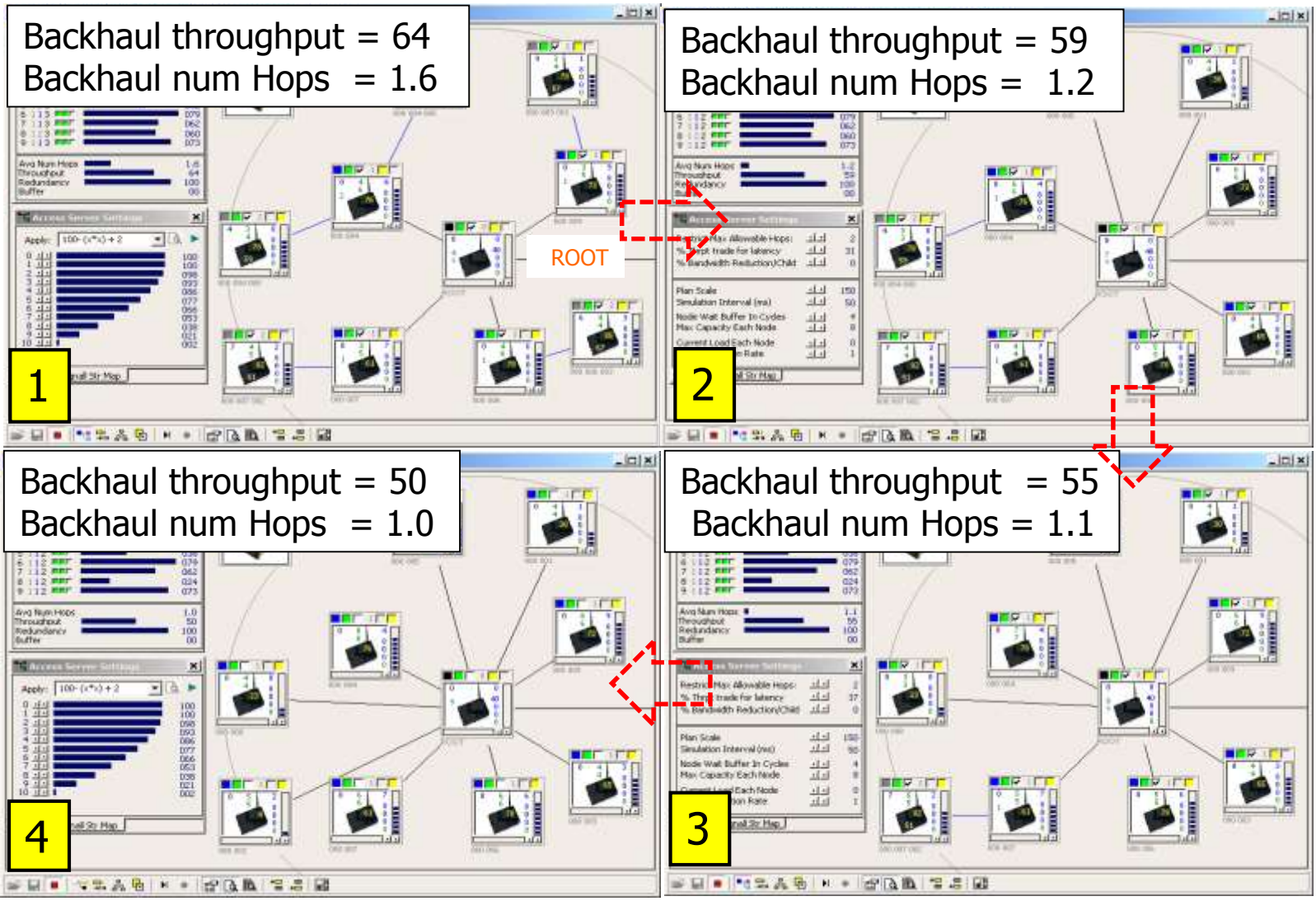
The shuttle buses are operating in a best efforts environment (The physical world, Intermittent IP connectivity) .

The performance is managed by a transceiver and protocol agnostic Mesh Control Layer to deal with mesh topology tuning when the physical world changes – mobility, disruption tolerance etc.

https://meshdynamics.com/real-time-mesh-network.html

US7583648-managing-jitter-latency
US8923186B1-chirp-networks.pdf
US9258765B1-chirp-networks.pdf
US9363651B1-chirp-networks.pdf
US9730100-terse-message-mesh-networks.pdf
US9819747-Chirp-networks.pdf
US10785316-Evolutionary-Wireless-Networks.pdf





Unlike wired networks, wire-less (radio, Infra-red, sound) become fainter over distance Some signals must be relayed and re-transmitted for the pollen to get to interested flowers far away (See 1 above). They may also need to be re-transmitted because they help Houston/Big Data discover or corroborate subscribed events of interest While Nature limits zones of influence, our digital versions, lacking evolution, will need occasional help from Houston.

Big Data servers periodically receive network health heart beats from the edge. The chirps report network health and jitter/latency of bus shuttle deliveries based on where interested parties now are: some are mobile.

Houston sends the directive to move parts of the network of publishers and subscribers towards lower latency and fewer hops – see item 2,3,4 above. Relay nodes move closer to the root node to reduce hop cost but this also reduces throughput because the fainter signals are more noisy, resulting in repeated send/receive. It's a balancing act.

The mesh control layer manages this balance to ensure "trains run on time". See also Collaborative Scheduling

The need for this a radio and protocol agnostic control layer is explained in The Abstracted Network for IOT

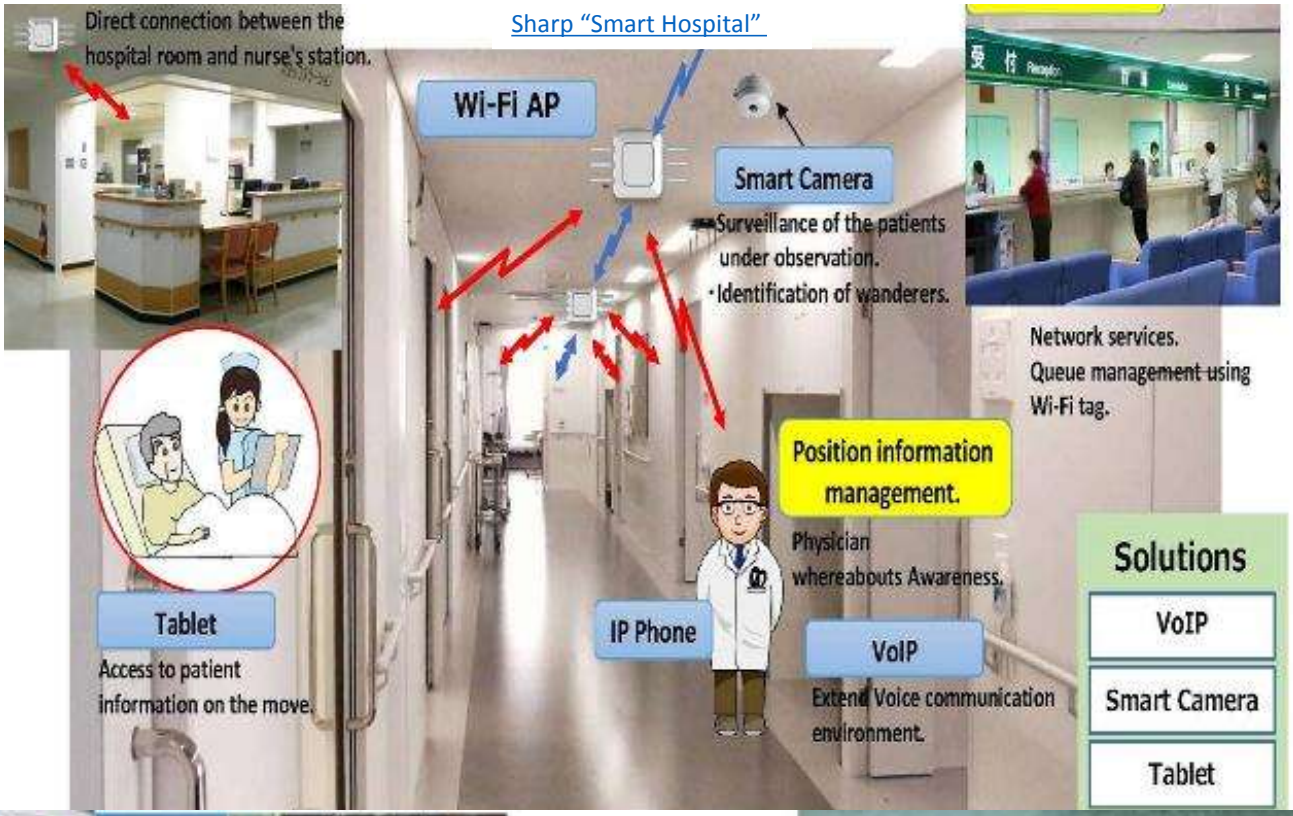
Details on patents and animations are here:

FloodingAnimation.pdf and Video Patents US 7,420,952 and US 8,462,747 US 9,172,738 B1 and its Color Slides

"Meshdynamics' propagator node software allows us to deploy WiFi networks today with minimal additional wiring and also incorporate emerging Internet of Things devices on the same infrastructure today and in the future." Mr. Arai Yuji, GM, Communication Division, Sharp Electronics, Japan.

"Meshdynamics Scalable and Open Pub Sub enables us to rapidly integrate with Enterprise Class, OMG (Object Management Group)-approved, industry- standard messaging systems from RTI (Real-Time Innovations), PRISMTECH, OpenDDS, and others to provide assured real time end to end performance, even if we scale to billions of devices at the edge." Curtis Wright, Sr. Research Systems Engineer, Space and Navy Warfare Center.

Sharp "Smart Hospital"



Sharp "Smart Industrial"