Wildland Fires

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Berkeley Lab CAG June 13, 2016

The FUEGO System

A PROBLEM READY FOR:

- PARADIGM SHIFTING THINKING
- DATA ACQUISITION, ANALYSIS, SIMULATION
- ACTIONABLE INTELLIGENCE

Talk Outline

- Introduction and Background
- Cost discussion and examples
- Phased Solution

We are an active collaboration of multiple LBNL, UC Departments and Campuses and Private Industry (Many skills are needed!)

- LBNL
- Space Sciences Lab
- Haas School of Business
- College of Engineering/Computer Vision
- College of Natural Resources
- UC San Diego
- UC Merced
- Fireball
- Drone America

Fundamental Conclusion:

Assuming growing efficacy, for a small fraction of **REAL** costs to Californians, $100's of millions and eventually billions of dollars can be saved for Californians. Starting soon. LBNL teammembers are ready!

Estimates of Average **REAL** Cost to each Californian is arguably $70/year to $120/year ($2B to $4B ~ 5x to 10X suppression costs – 2003 Cedar Fire in San Diego was 50X suppression…)

The University of California Labs and our public/private partnerships offer some incremental, transparent solutions. A 5% savings, achievable now we believe, would save Californians at least $100M/year.

Greenhouse Gas Contribution:

California Fires are speeding up climate change and, as ~ 6% of California's C02 comes from wildland fires (from a UC Berkeley study --

(http://news.berkeley.edu/2015/04/15/california-carbon/).

Why Should LBNL/UCB/Fireball Do This?

- Good opportunity to save lives and money and environmental damage in support of CalFire's Mission

  (CalFire does a great job!)

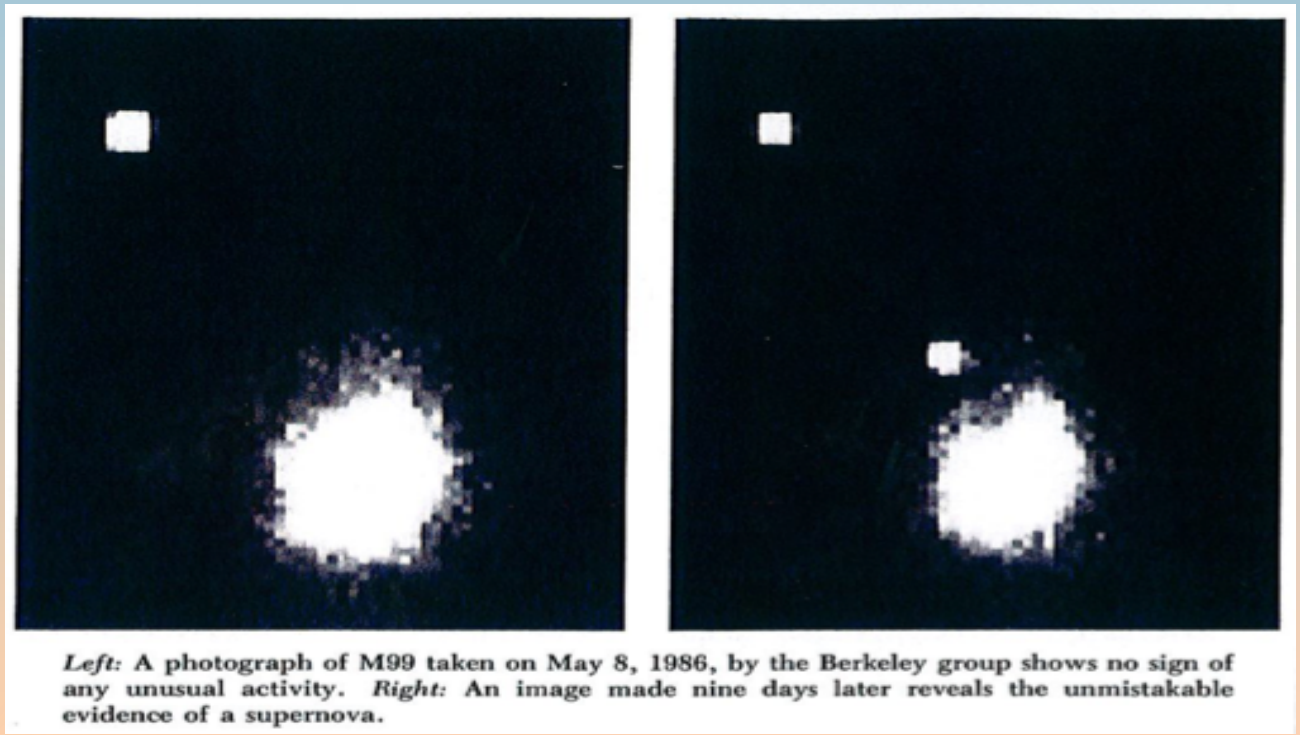
- We are arguably great (Nobel Prize, etc.) at piloting data/sensor/ computationally intensive, physics based solutions for these types of problems

- Fireball's good track record with CalFire

- We can reduce Climate Change

Beginning of a Mission Concept: Supernovae!!

Explosive end of a star's life, which can be seen across the Universe! Supernova can be as bright as a whole galaxy! But hard to find!!



Left: A photograph of M99 taken on May 8, 1986, by the Berkeley group shows no sign of any unusual activity. *Right:* An image made nine days later reveals the unmistakable evidence of a supernova.

This was the first supernova we saw, in M99 galaxy in 1986.


Congratulations Saul!

Start of *FUEGO*

Fire **U**rgency **E**stimator from **G**eosynchronous **O**rbit

(and Associated Data Systems and lower-altitude steps in between…)

Supported by the Vice Chancellor for Research, UC Berkeley

- Early detection and ***on-going management*** of wildland fires
  - natural; accidental; terrorist
  - Developing the Fire Data Hyper- Cube
- Valuable for the United States and the world – can become a business for CA!
- Geosynchronous orbit for 24/7 coverage
- Supplement ground & air observations
- Provide real time input for models for prediction and suppression resource allocation
- Supplement other space-borne geo observatories
- Requires real-time assessment of **urgency.**
  - Urgency is the key ingredient! *Must* be made quantitative!
  - Requires tight integration with **Geographic Information Systems**

Questions Concerning Economics

The hierarchy of fire accounted and un-accounted costs to Californians :

1) Suppression Costs
2) Property -> Insurance rate increase
3) Public Utility Infrastructure -> rate increases
4) Eco-system
5) Lost business
6) Human suffering and lives lost
7) Accelerating Climate Change

Fires will get worse in California, based on current climate models…

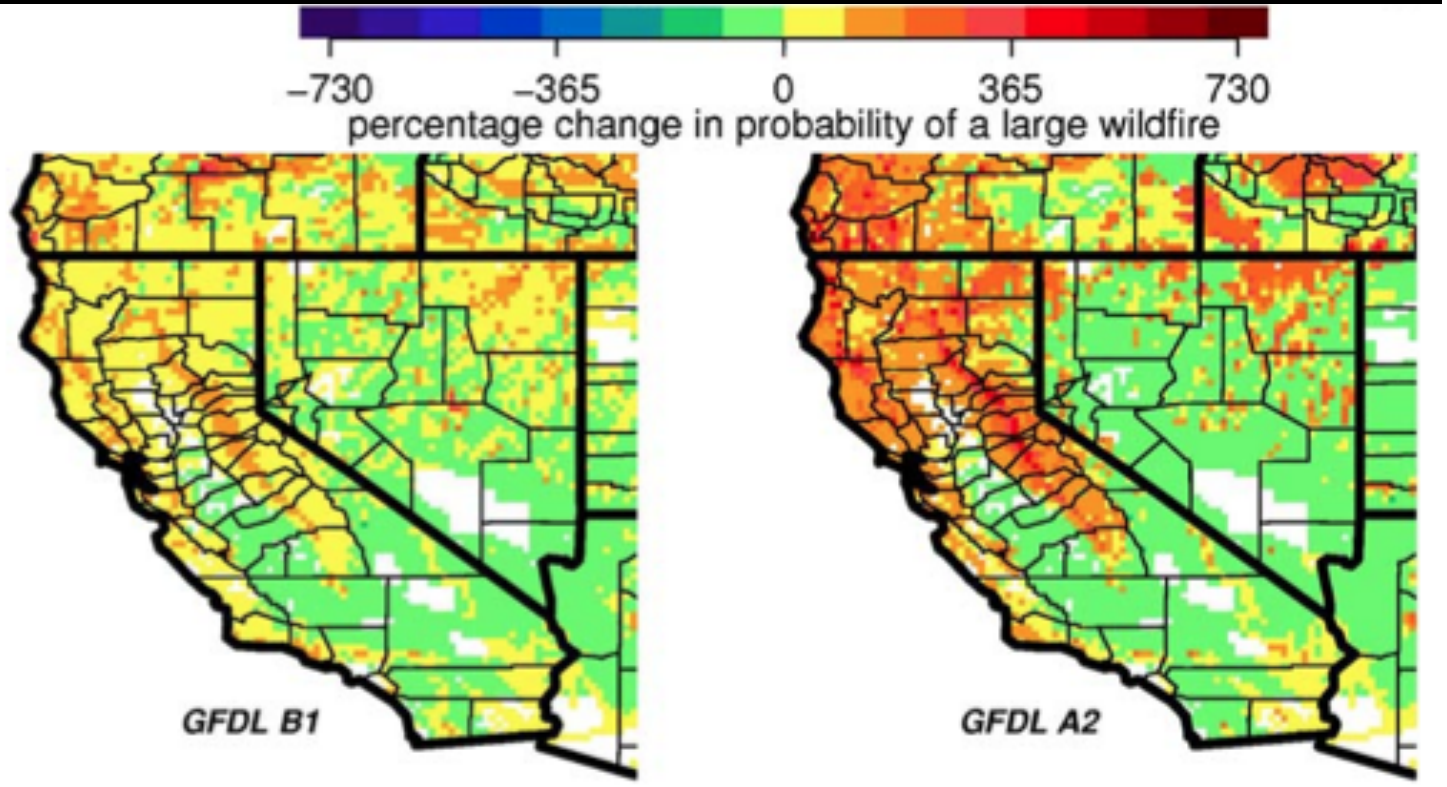
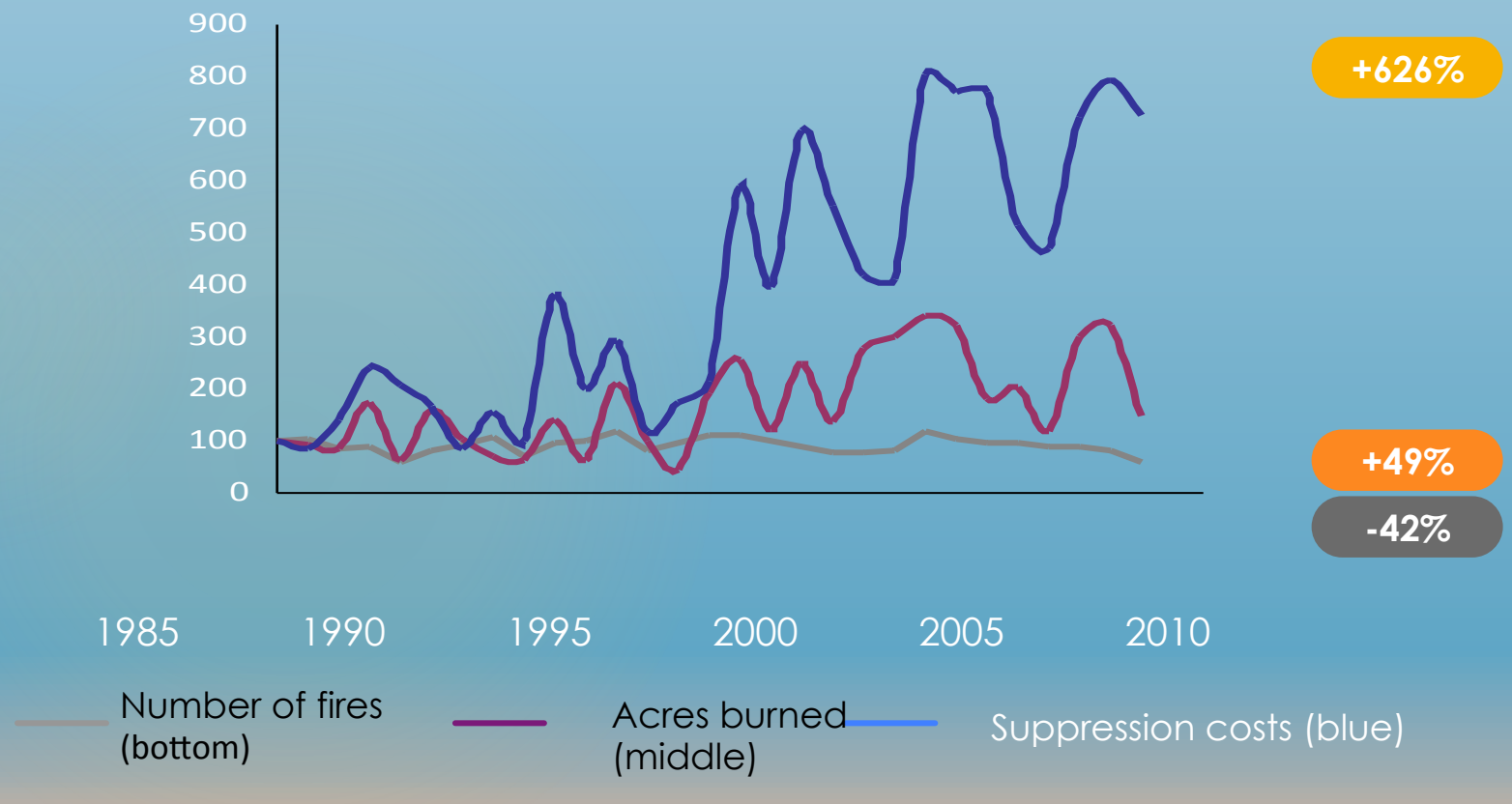


Fig. 7 Percentage change in probability of a large wildfire by 2070–2099 over the 1961–1990 reference period for four climate scenarios

The financial and environmental impact of wildfires in the US has increased dramatically over the last 30 years

- The impact of wildfires in the US (rebased, 1985=100)



Even though the US has seen 42% fewer wildfires in 2013 as compared to 1985, acres burned have increased significantly, and costs have risen over 600%

Reasons include:

1. A build-up of fuels resulting in part from past fire suppression policies
2. A warming climate, including drought in the West
3. to fire-prone public landsThe development of homes adjacent

California Wildfires Drive Up Insurance Costs For Homeowners

Cody Drabble

Wednesday, September 17, 2014 | Sacramento, CA | Permalink

File Photo / AP

Donna Hoffman and her husband have lived in El Cajon for 18 years. In that time, the most they paid for homeowners insurance was about $2,300 per year.

Last year's renewal notice came as a surprise. Facing the need to cover the growing risk after recent wildfires in the inland San Diego community, their insurer sent notice that their homeowners insurance premium would rise jump $4,000. The Hoffmans negotiated for a higher deductible to maintain the lower premium. Even with that, the policy renewal notice for this year went up to $7,200.

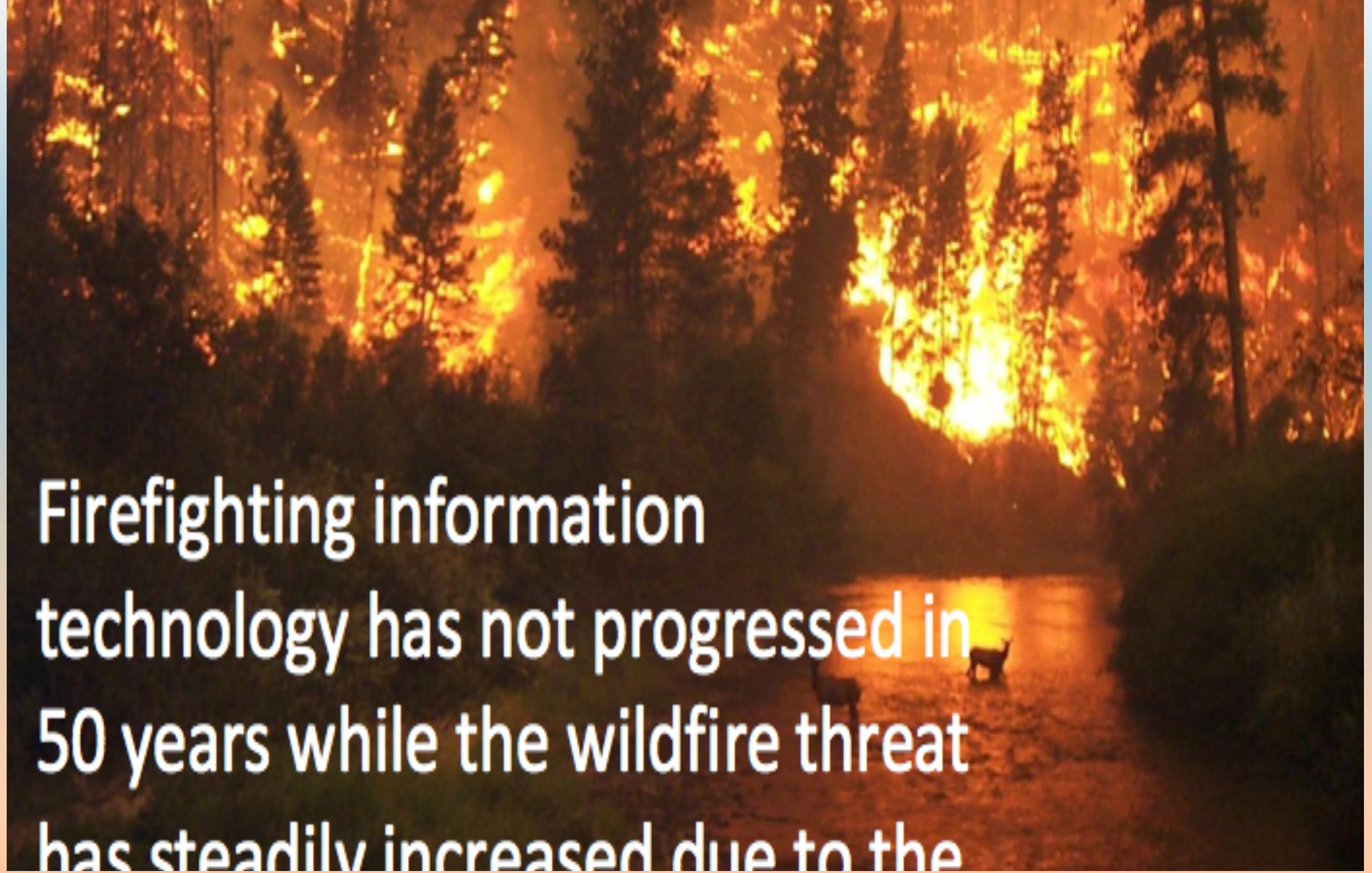
"I can't justify that kind of increase," Hoffman said. "I'm doing anything I can possibly do at this point. I'm ready to move. I'm really upset by the $5,000 increase just for the insurance. That's scary, next year it could be $10,000."

Just like the Hoffmans, many California homeowners living in high fire risk communities are feeling burned by insurance companies. Premiums cost more. Deductibles are higher. Carriers are sending out non-renewal notices to swaths of Sierra foothill towns. The cost of living near California forests is leaving some homeowners feeling trapped.

Big Data Predicts Bigger Fires

Jerry Davies, an insurance industry consultant on the board of the California Fire Safe Council, says insurance companies are changing the way they do business in the state with the help of sophisticated computer models that predict fire behavior.

Fire Primer: Example 1:
Oakland Fire, 1991: 25 People died, 150 injured, 3,000 dwellings destroyed. Financial impact > $1.5 billion

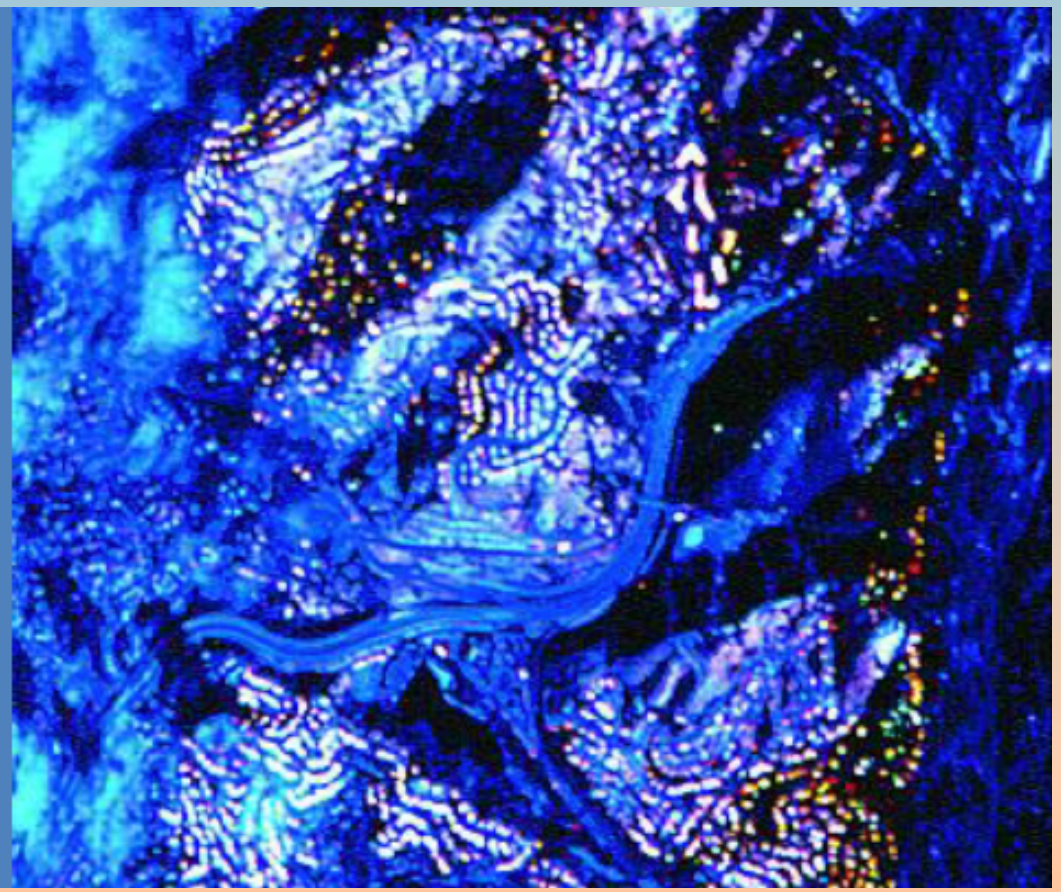

Firefighting information
technology has not progressed in
50 years while the wildfire threat
has steadily increased due to the

Infrared Image of Oakland Fire acquired by Donn Walklett, FUEGAN in NASA airplane –

(There was probably strong infrared signal from progenitor fire)

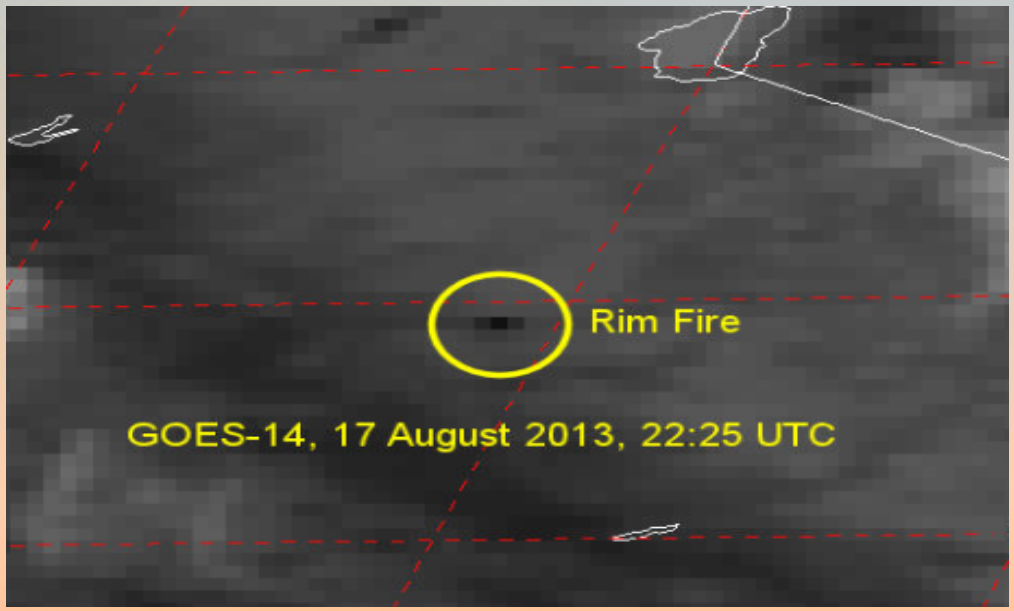
was a "wake-up call" to everyone who assumed that wildfires were not a major threat to urban and suburban communities.

The adjacent image was acquired by a NASA infrared scanner during the peak of the wildfire. The area was completed obscured by smoke but the NASA scanner was able to see through the haze that otherwise was impenetrable by visible light. Every bright dot is a house or apartment building on fire.



Example 2: Rim Fire

- Hunter's Campfire, 3:25 PM, August 17 (GOES saw it at 3:25), and "discovered/reported" after 4:30 pm (estimate)
- Reported/discovered by phone an hour or two later than expected FUEGO threshold
- Turned into California's 3rd biggest fire -- 260,000 acres (400 square miles) *BTW: California is 100,000,000 acres area*



Environment News Service

International Daily Newswire | Since 1990 | We Cover the Earth for You

AIR/CLIMATE | BUSINESS | ENERGY | GOV/POLITICS | OCEANS | TRANSPORT | WILDLIFE

Rim Fire Suppression Costs Exceed $100 million

The Modesto Bee

modbee.com

HOME | NEWS | SPORTS | OPINION | LIVING & ENTERTAINMENT | BUSINESS | PHOTOS &

News > Local News

Report puts $797M price tag on Rim fire's damage to ecosystem

BY JOHN HOLLAND

jholland@modbee.com December 25, 2013

PG&E faces $440 million in costs for Butte Fire

By George Avalos, gavalos@bayareanewsgroup.com

POSTED: 05/03/2016 08:50:14 AM PDT | UPDATED: A DAY AGO

FILE - In this Sept. 12, 2015, file photo, Vernon Fire Department crew of Engine 11 hose down hot spots on home burned in the Butte Fire on Mountain Ranch Road a few miles east of San Andreas, Calif. The California Department of Forestry and Fire Protection released a report Thursday, April 28, 2016, detailing the cause of the fire in Calaveras and Amador counties. (Paul

Example 3: Butte Fire:

But Optimistic early discussions with PG&E underway.

Because USFS mapping aircraft committed in the PNW, no real perimeter map during first 3 days.

SDG&E's Plan to Charge Ratepayers for 2007 Wildfires Hit With Opposition

SDG&E first owed $463 million to firestorm victims after an independent report by Cal Fire determined its power lines caused the massive 2007 wildfires in San Diego

By Samantha Tatro

ESCONDIDO. CA - OCTOBER 23: Firefighters battle a wildfire October 23, 2007 in the Del Dios

TRENDING STORIES

1 Navy Investigates 17th Threat in Long Series

Valley fire damage likely to surpass $1.5 billion

(1 of 4) Jay Albertson looks over the remnants of his Hidden Valley Lake home, destroyed by the Valley fire, on Tuesday, September 15, 2015. (Christopher Chung/ The Press Democrat)

The State

Fire Insurance Payouts Could Reach $3 Billion

State and industry figures show that last month's blazes were the costliest since flames ravaged San Francisco after the 1906 quake.

November 18, 2003 | Kenneth Reich | Times Staff Writer

State government and insurance industry sources said Monday that insurance payouts from the Southern California wildfires could hit $3 billion and that more claims are being filed than originally predicted.

This would make the October wildfires the costliest conflagration since 1906, when a great fire that followed the massive earthquake in San Francisco caused $5.7 billion in damage, in inflation-adjusted dollars.

Norman Williams, a spokesman for state Insurance Commissioner John Garamendi, said that 12,769 claims have been filed so far in the recent wildfires and that the total policy limit under those claims is $3.45 billion.

But not every claim may entitle a policyholder to the maximum benefit. The Personal Insurance Federation, a leading industry lobbyist in Sacramento, is estimating that total payouts will range from $2.5 billion to $3 billion, according to Jerry Davies, a spokesman for the group.

FROM THE ARCHIVES

Modesto prosecutors to retry 72-year-old man in...
May 7, 2013

Man serving life sentence for 1997 arson deaths ordered...
April 12, 2013

Paying for unemployment

SDG&E Way to deal with fire:

SDG&E WANTS RATEPAYERS TO PAY FOR ITS WILDFIRE COSTS

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August 2015 Articles

SDG&E California Public Utilities Commission (CPUC) wildfire costs Supervisor Dianne Jacob 2007 firestorms

By Miriam Raftery

Updated August 8, 2015 with comments from SDG&E, clarifications/corrections.

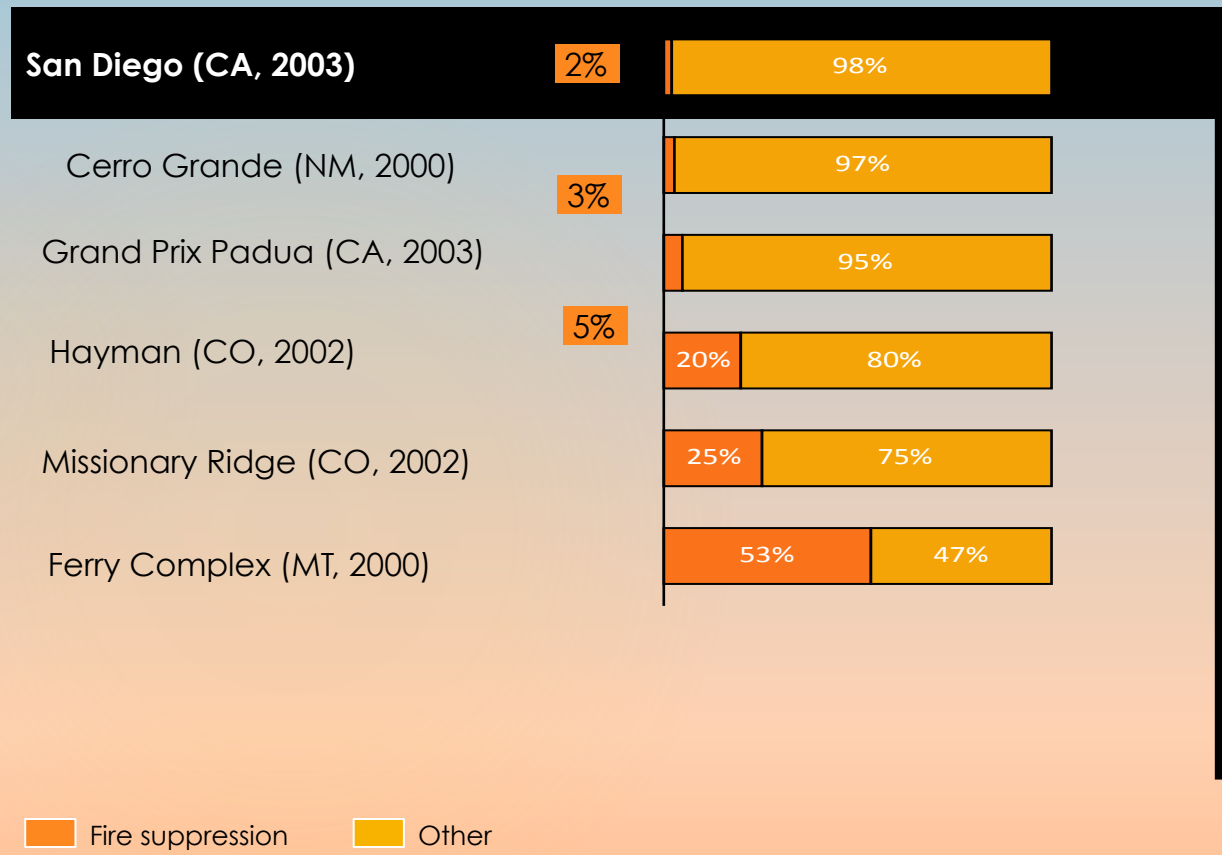
August 7, 2015 (San Diego's East County) – SDG&E is asking the California Public Utilities Commission to pass on costs to ratepayers for the uninsured costs of legal settlements for the utility's role in causing three major fires in the 2007 firestorms. The utility has announced plans to file an application this fall seeking to recover those costs, which could be as high as $367 million.

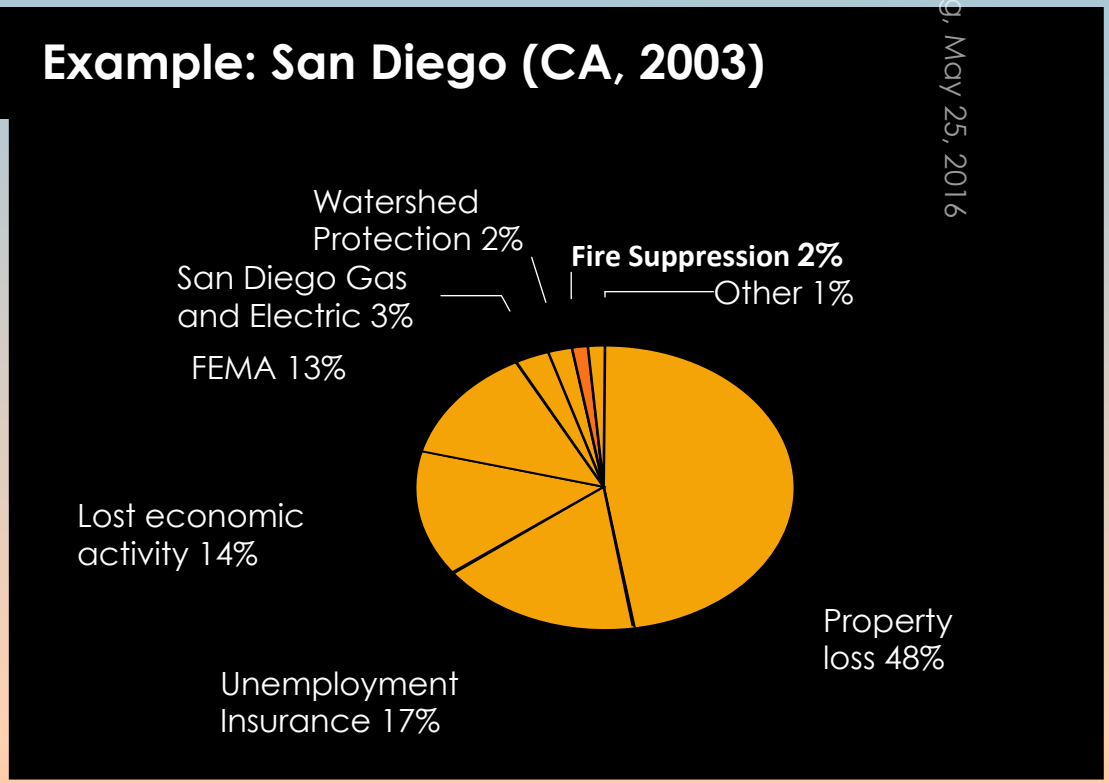
Collectively, the 2007 firestorms ranked as the second worst wildfire in California history at the time, triggering a mass evacuation of a half million people. The fires destroyed over 1,300 homes and killed two people. Cal Fire's investigation found SDG&E equipment responsible for the Witch, Guejito and Rice fires. Cox Communications was also found responsible for one of the 2007 wildfires. Extreme weather conditions and high winds also contributed to the fires' rapid spread.

B ECONOMIC IMPACT – Suppresion Costs can be a tiny part of the story…

Full economic benefits are considerably larger, with 47-98% of costs related to factors other than suppression

Full economic costs of selected fires, breakdown [%]





The Way Forward and Work/discussion in Progress!

Current Work: Enhanced FUEGO "E-FUEGO"

Sensors at many altitudes (including fire watch towers)

Phase 1: Begin now!

- **1)** Now - run for three years) -- total cost - $1.66M - - ***total*** societal cost savings – **assume 5% fire damage reduction** -> $100M to$200M/year

a) Fire management of existing fires -
frequent infrared mapping, simulation, and delivery
of actionable intelligence to incident commanders.
Estimated Savings Goal within 3 years: 5% less damage
in the Mega-fires

b) Simulations become validated, tuned, and become part of actionable intelligence. Also, allow much better accounting

c) Early smoke detection from California fire watch towers:

d) Use of Air Force Satellites Imagery - hard to quantify savings

Automated Detection of Smoke from Fire (UC Berkeley Computer Vision Program)

- (note Mt. Palomar 200" Dome)
- Work of Dr. Stella Yu, Comput and Will Cramer (Under Grad)

Does knowing where a fire is and how it is spreading help to fight a fire?

Are there assets in California that can collect/disseminate over-all common operating intel in near real-time?

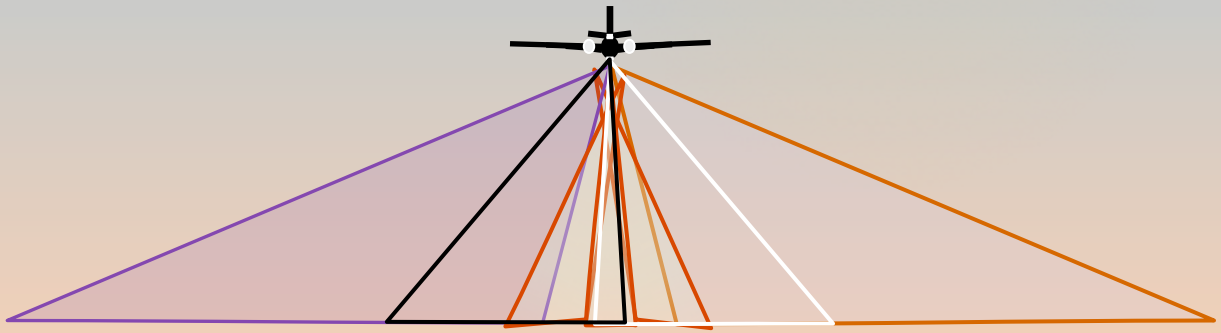
Near Real-Time, High Resolution, Day/Night Mapping and Fire Characterization

NO UP-FRONT MONEY EXPECTED FROM GOVERNMENT

FIRE-FINDER

9 cameras

3 each at 3 Infrared Wavelengths



Critical Objectives:

- ✓ Find & map perimeters of fastest moving fires / long-range spotting ⇨ Analysis ⇨ Broadcast
- ✓ Simultaneously find smallest burning fuel elements -- spots & for action to prevent re-kindle

Intel is a force multiplier

Wildland Fire Intelligence Needs Improvement

1. Mapping data collection at low Frequency => Lack of Continuity => Reduced appreciation for changing conditions

2. Information currently lacking real specificity
   a) Geographic location (perimeters well-known after USFS night flight only)
   b) Fire Behavior – rate of spread, intensity, drivers of behavior, duration of runs
   c) Fuels
   d) Threatened assets rarely called out
   e) "Potential" in different section of fire not characterized
   f) Weather (not perfect but is relatively well characterized)

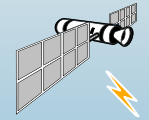
3. Lack of Distillation into Common Operating Picture that is useable for both strategy and tactics. "Scout" is headed there.

4. Predictive understanding (knowing what fire will do is an experiential art (good but uneven)

5. Intelligence dissemination weak but improving

Real-time Tasking, Collection, Processing, Analysis, and Dissemination

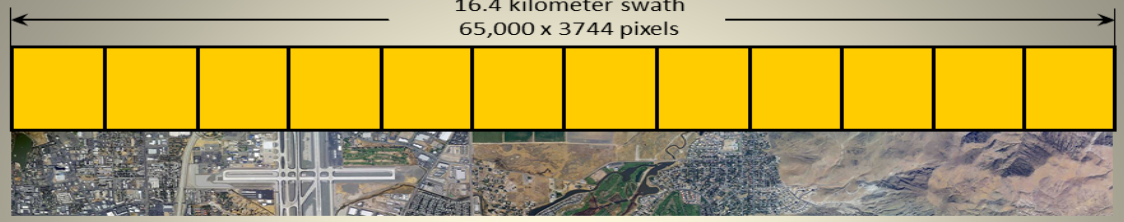
Battlefield Airborne Communications Node (BACN)



ARGUS in WB-57 Pallet

ARGUS Performance at 50,000 feet

59 degree Field of View
16.4 kilometer swath
65,000 x 3744 pixels



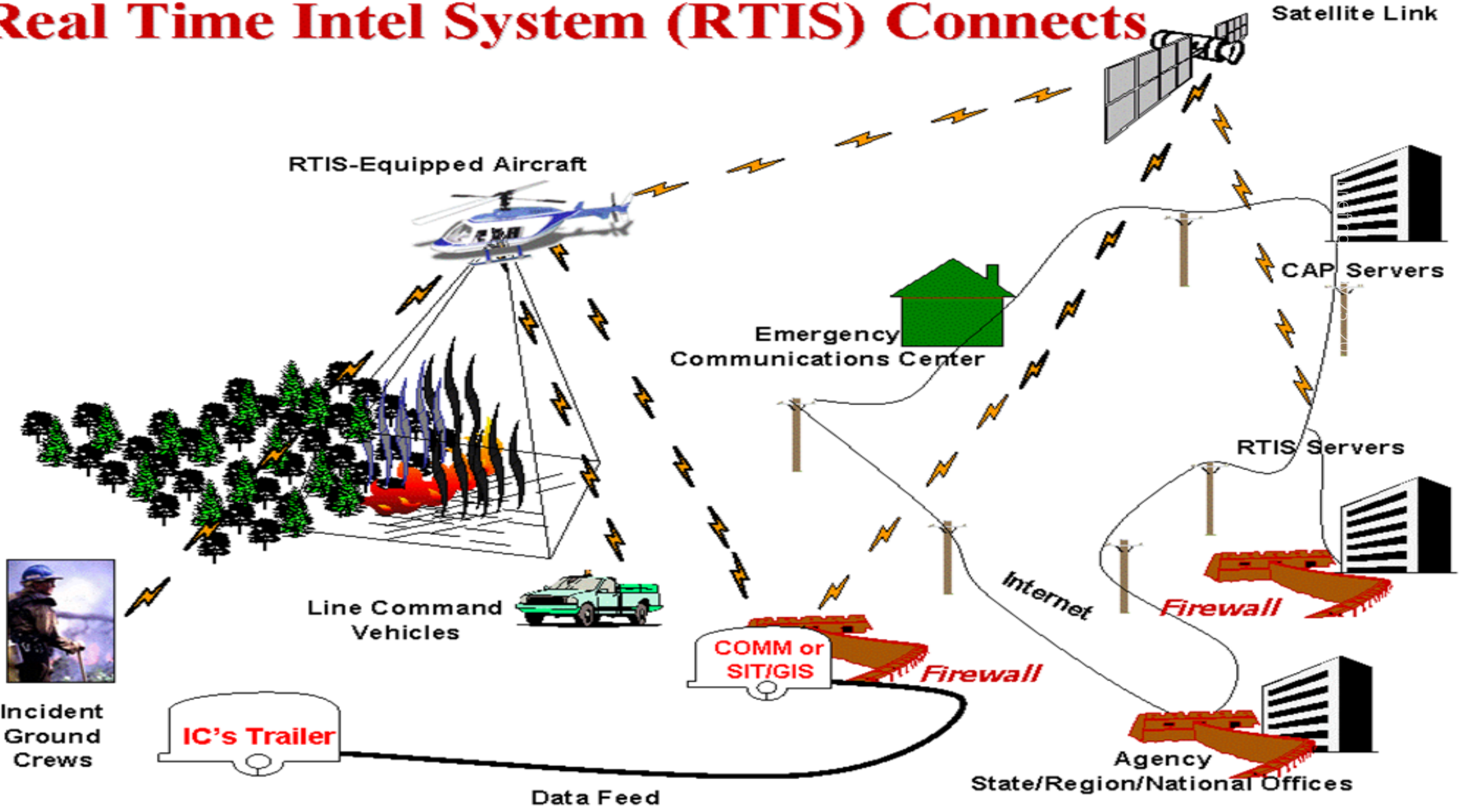
Standard Configuration (400 mm lenses)

Altitude	System Swath	Nadir GSD	Outer GSD	Ground Speed	Forward Overlap	Side-lap	Frame interval	Max Map Rate	Practical Map Rate	Nominal mapping duration	Area/Flight
15,200 m 50,000 ft	59 deg. 16.4 km 9.3 mi	24 cm 9.6 in	37 cm 14.8 in	325 kts	39%	20%	3.3 s	9900 sqkm/hr	6,400 sq. km/hr.	3.25 hours	20,000 sq. km 7,700 sq. mi.

Ultra-wide Configuration (Mix of 400, 200, 100, 85 mm lenses)

Altitude	System Swath	Nadir GSD	Outer GSD	Ground Speed	Forward Overlap	Side-lap	Frame interval	Max Map Rate	Practical Map Rate	Nominal mapping duration	Area/Flight
15,100 m 50,000 ft.	138 deg 18.4 km 11.4 mi	1.2 m 47 in	1.2 m 47 in	350 kts	70%	20%	5 s	23,880 sq.km/hr	15,533 sq km/hr	3.25 hours	50,483 sq. km 19,491 sq. mi.

Real Time Intel System (RTIS) Connects



Predictive Simulation Model

- Uniform agreement among scientists and improvements in simulation await high frequency measurements of fire spread in "Measured" fuel beds.
- Idea of Measured fuel bed is almost a joke. Fuels are complex.
- With data one can run model, measure error, run model backward to estimate where the error lies. Run forward again…. = Deep Learning
- Result is a measure of the fuel parameter

- Coupled Atmosphere-Wildland **Fire** Environment **Model** (CAWFE) Janice Coen NCAR, Boulder CO
- Farsite Mark Finney Missoula Fire Lab USDA/FS

- *COMPLETE VETTING BEFORE DEPLOY*

Does Better Mapping Really Help?

Fireball observations over 16 years

1. Only if the intelligence gets used
2. When you are runnin' and gunnin' how often do you really know where you are?
3. Can you communicate your location? Is that dangerous?
4. Can you communicate your intent?

5. Current and previous perimeters show how the fire is flowing through the fuel
   - Experienced people will quickly relate illustration to what they have see in the past.
   - It will be easier to look ahead to consider changing potential and special hazards
   - Changes the way resources are deployed
   - Helps ID and mitigate safety concerns
   - The computer models will be improved and not broadcast until vetted
6. Has the Campbell Model helped? Its right and it provided a communication platform
7. Has your use of Google Earth increased? How exactly does GE help?
8. Every feature has geo-coordinates and which can be queried/displayed
9. Maps are a communications tool and communications is critical

10. It is a rare fire where I don't catch a flare-up in the act of taking off.
11. Teams that use the data systematically go home sooner

12. A digital map is not always better than a paper map

Phase 2: Working within 5 years

- **2) Phase 2**: (start preparing for now - run for five years) -- ***total*** costs - $10M - ***total*** societal savings – 20% reduction in fires

  a) High Altitude UAV's/ballons over San Diego and LA Basin and other areas.

- b) Detect fires early, and deploy great CalFire areial tankers and helicopters

- c) routine and excellent use of simulations. Better and better predictive powers are used to fight fires and grade their danger

Phase 3: Begin now, deploy in 10 years

Total costs $100M, $10M/year on-going, savings, $10B/year

a) FUEGO Geosynchronous coupled with 100kfeet UAV's detect almost all fires over 10 square meters, and rapid response by DC10's stops them within 45 minutes of ignition

b) Simulations so fine-tuned, fire behavior and predictability very well understood and managed. CA sells technology to the rest of the world, generates income of $100M/year or more.

c) Program is self-supporting on sales revenue.

New Idea: FUEGO as an Attached Payload $60M compared to $400M -- use CHIRP System Ideas…

- Comsats are regularly flown to geosynchronous orbit
- Comsats are large! Tons, kilowatts, gigabits/sec.
- Comsats can often host attached payloads.
- Benefits of being an Attached Payload:
  - Host provides launch service
  - Host provides orbit maintenance
  - Host provides electrical power
  - Host provides uplink & downlink
  - Host provides attitude control
  - Host provides known monthly operations cost
- FUEGO in particular has modest requirements compared to comsat capabilities. Good match!

Immediate Conclusion from on-going work

- **INTELLIGENCE COLLECTION ON FIRES HAS CHANGED LITTLE IN 50 YEARS!**
- **SENSING TECHNOLOGY EXISTS**
  - **Agency motivation**
  - **Approach Different from military intel**
- **WORK ON DATA FLOW**
  - **Reduction of Mass of information to "at a Glance Intel" is a fun Challenge**
  - **requires some money**
- **SIMULATION USEFUL PREDICTIVE MODELS ARE A BIG DATA PROBLEM IN INFANCY**
  - **We are collecting data to exercise some models**
  - **How close to physics does a model need to be**
  - **Application of data assimilation techniques need to be worked out**
  - **Would an ensemble of models be helpful?**