GROUP 47

DOTS™

Introduction to DOTS

- **200+ Year Digital Preservation**
- **20 TBytes per reel**
- **Immune from Malware & EMP**
- **Photonics Driven Recording**
- **Provides Data Provenance**
- **Data is Retrieved with a camera**

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DOTS What's New?

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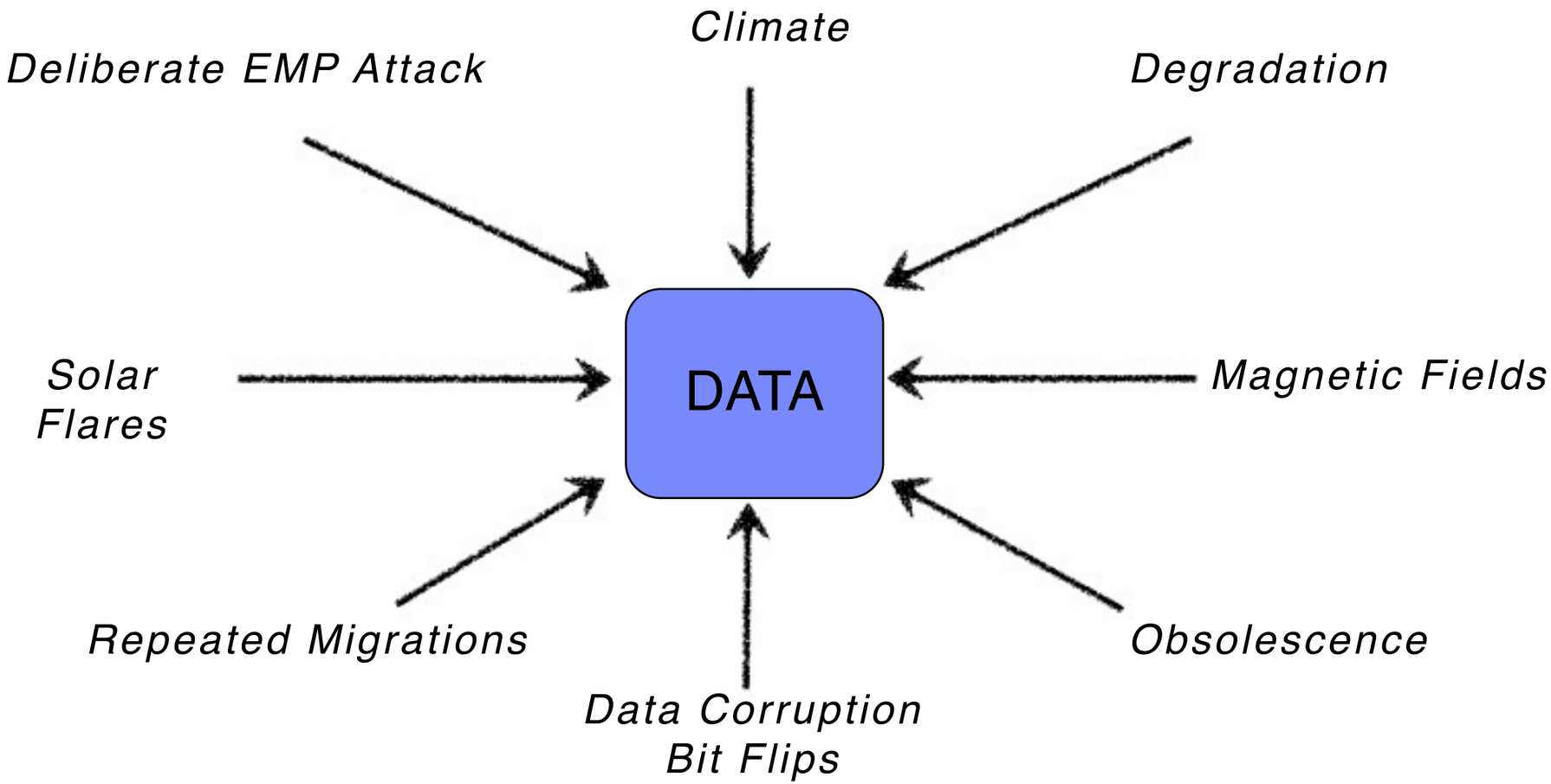
- 20 TeraBytes per 12" reel of ¾" media

* Artist's conception of a DOTS open reel

The Digital Preservation Problem

Current methods for archiving digital data on magnetic media create risk and uncertainty…

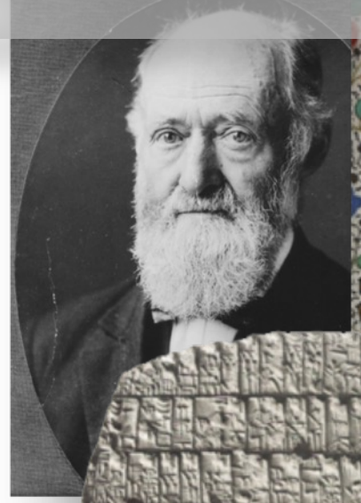


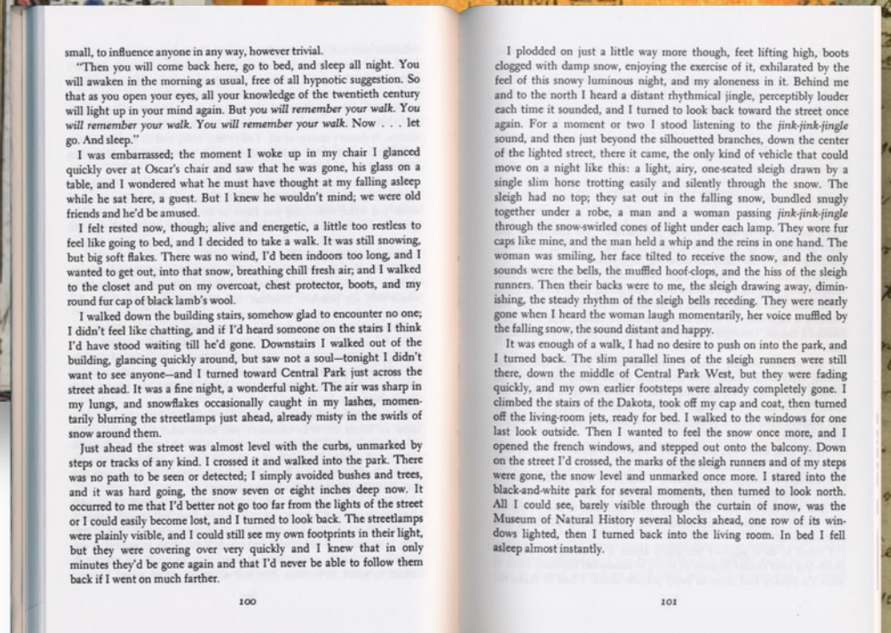
The Digital Preservation Problem

Yet…

Proposed Digital Preservation efforts, including DNA, LTO, glass, and others require increasingly complex methods for writing and reading data

Archivists will tell you, the ONLY successful methods to preserve information have *always* been visual & simple




small, to influence anyone in any way, however trivial.

"Then you will come back here, go to bed, and sleep all night. You will awaken in the morning as usual, free of all hypnotic suggestion. So that as you open your eyes, all your knowledge of the twentieth century will light up in your mind again. But *you will remember your walk. You will remember your walk. You will remember your walk.* Now . . . let go. And sleep."

I was embarrassed; the moment I woke up in my chair I glanced quickly over at Oscar's chair and saw that he was gone, his glass on a table, and I wondered what he must have thought at my falling asleep while he sat here, a guest. But I knew he wouldn't mind; we were old friends and he'd be amused.

I felt rested now, though; alive and energetic, a little too restless to feel like going to bed, and I decided to take a walk. It was still snowing, but big soft flakes. There was no wind, I'd been indoors too long, and I wanted to get out, into that snow, breathing chill fresh air; and I walked to the closet and put on my overcoat, chest protector, boots, and my round fur cap of black lamb's wool.

I walked down the building stairs, somehow glad to encounter no one; I didn't feel like chatting, and if I'd heard someone on the stairs I think I'd have stood waiting till he'd gone. Downstairs I walked out of the building, glancing quickly around, but saw not a soul—tonight I didn't want to see anyone—and I turned toward Central Park just across the street ahead. It was a fine night, a wonderful night. The air was sharp in my lungs, and snowflakes occasionally caught in my lashes, momentarily blurring the streetlamps just ahead, already misty in the swirls of snow around them.

Just ahead the street was almost level with the curbs, unmarked by steps or tracks of any kind. I crossed it and walked into the park. There was no path to be seen or detected; I simply avoided bushes and trees, and it was hard going, the snow seven or eight inches deep now. It occurred to me that I'd better not go too far from the lights of the street or I could easily become lost, and I turned to look back. The streetlamps were plainly visible, and I could still see my own footprints in their light, but they were covering over very quickly and I knew that in only minutes they'd be gone again and that I'd never be able to follow them back if I went on much farther.

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I plodded on just a little way more though, feet lifting high, boots clogged with damp snow, enjoying the exercise of it, exhilarated by the feel of this snowy luminous night, and my aloneness in it. Behind me and to the north I heard a distant rhythmical jingle, perceptibly louder each time it sounded, and I turned to look back toward the street once again. For a moment or two I stood listening to the *jink-jink-jingle* sound, and then just beyond the silhouetted branches, down the center of the lighted street, there it came, the only kind of vehicle that could move on a night like this: a light, airy, one-seated sleigh drawn by a single slim horse trotting easily and silently through the snow. The sleigh had no top; they sat out in the falling snow, bundled snugly together under a robe, a man and a woman passing *jink-jink-jingle* through the snow-swirled cones of light under each lamp. They wore fur caps like mine, and the man held a whip and the reins in one hand. The woman was smiling, her face tilted to receive the snow, and the only sounds were the bells, the muffled hoof-clops, and the hiss of the sleigh runners. Then their backs were to me, the sleigh drawing away, diminishing, the steady rhythm of the sleigh bells receding. They were nearly gone when I heard the woman laugh momentarily, her voice muffled by the falling snow, the sound distant and happy.

It was enough of a walk, I had no desire to push on into the park, and I turned back. The slim parallel lines of the sleigh runners were still there, down the middle of Central Park West, but they were fading quickly, and my own earlier footsteps were already completely gone. I climbed the stairs of the Dakota, took off my cap and coat, then turned off the living-room jets, ready for bed. I walked to the windows for one last look outside. Then I wanted to feel the snow once more, and I opened the french windows, and stepped out onto the balcony. Down on the street I'd crossed, the marks of the sleigh runners and of my steps were gone, the snow level and unmarked once more. I stared into the black-and-white park for several moments, then turned to look north. All I could see, barely visible through the curtain of snow, was the Museum of Natural History several blocks ahead, one row of its windows lighted, then I turned back into the living room. In bed I fell asleep almost instantly.

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GROUP

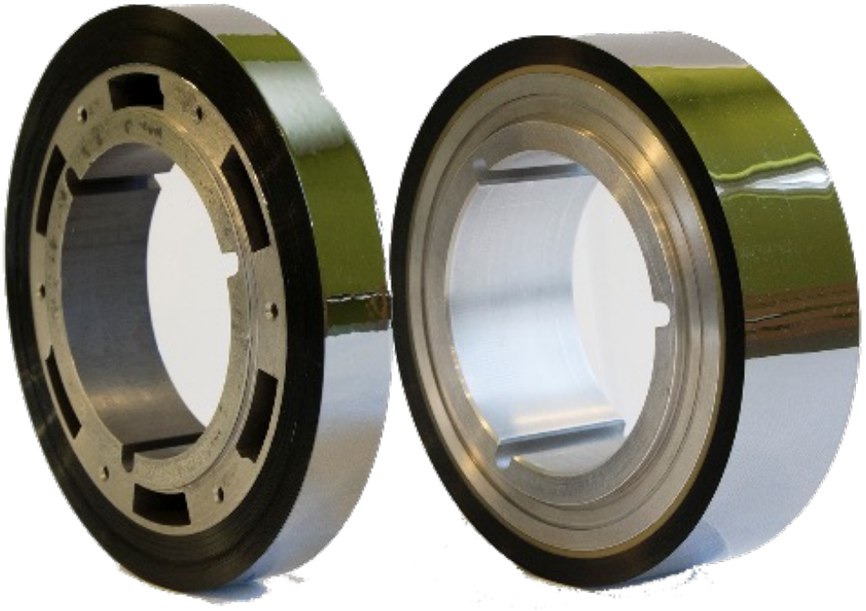
Why DOTS is Revolutionary in its Simplicity

- WORM[1] Archival for well over 200 years[2]
- Ensures Data Provenance
- Data can be seen, and recorded in human readable form
- Data is retrieved with a camera
- Immune to magnetism, EMP, & can withstand environmental stress
- **DOTS** can be stored anywhere from -6° to 66° C (21° - 150° F)
- 20 TBytes capacity per reel
- Hardware devices are backwardly compatible for all previous generations
- TCO superior to endless migration and paying for Cloud storage

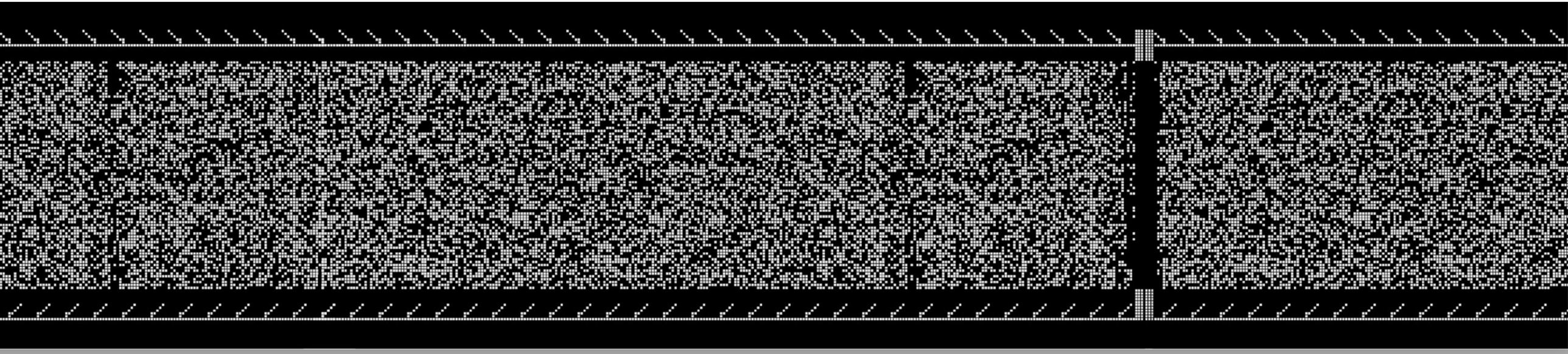
[1] Write Once Read Many
[2] Results of Carnegie Mellon University Life Testing

DOTS What is it?

- **DOTS,** Digital Optical Technology System, is a non-magnetic method of representing data visually on a metal alloy
- A dot equals a binary 1, if there isn't a dot, it equals a binary zero
- Data is written with a laser at 1 Gbyte/second
- Data is read with a camera at equal or faster speeds.
- When read under polarized light, the metal alloy becomes dark with the written data contrasting sharply with the background



Low resolution example of data on ½" tape



DOTS What is it?

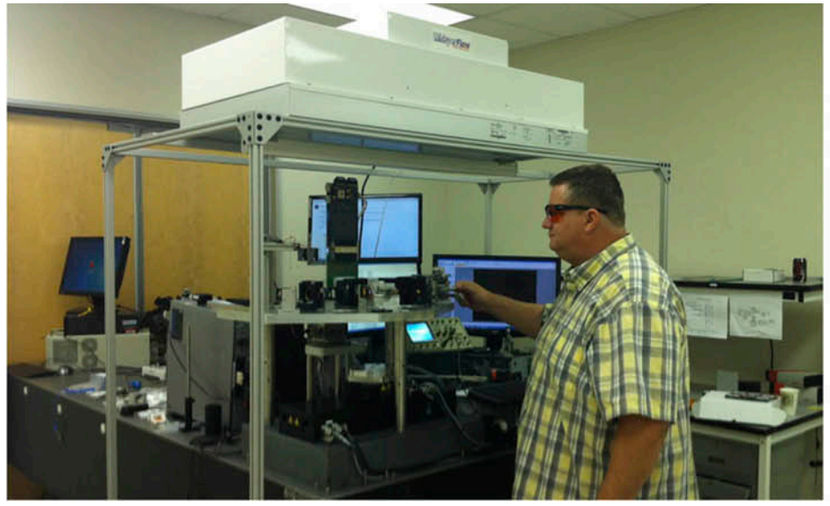
- **DOTS** is a phase change media composed of a patented metallic alloy sputtered on an archival polyester base (e.g.: Aramid, Mylar™, Estar™)
- Standard manufacturing techniques are used to create **DOTS** tape
- **DOTS** media and prototype recorder/readers were successfully built by early 2001
- Carnegie Mellon University tested **DOTS** and concluded an archival life of 200 to 2000 years
- Group 47 has dramatically improved and simplified the hardware design with an engineering upgrade/refresh, and strengthened the patent portfolio
- Group 47's new design was proven in a contract with the CIA
- Components for **DOTS** recorder/readers employ off-the-shelf imaging and laser technologies

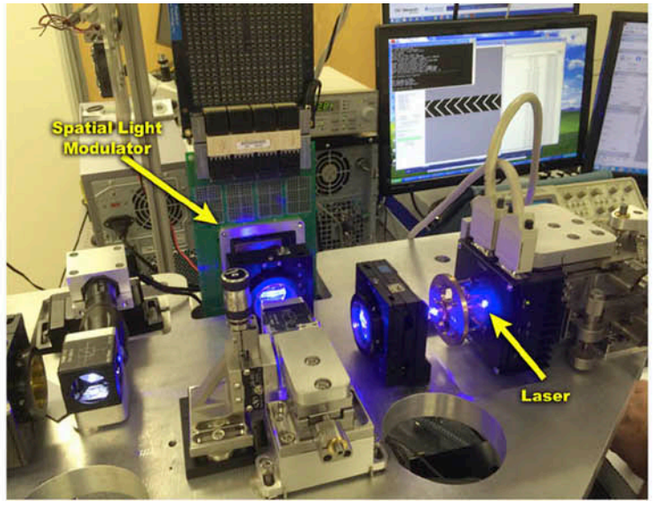
The Product

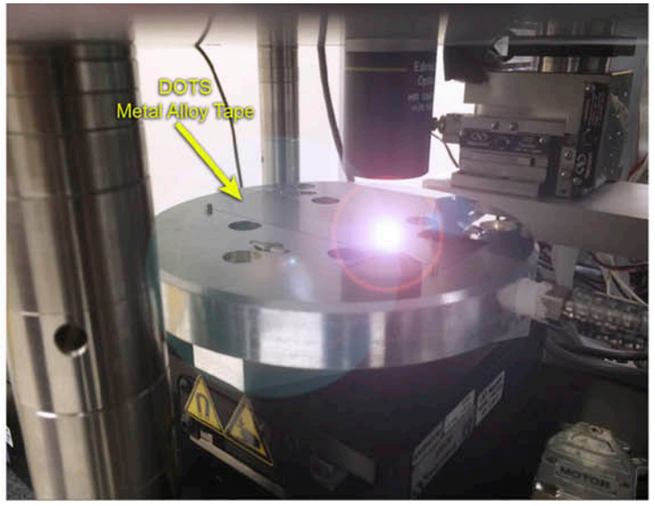
- Because the data is represented visually, as long as people have access to cameras, the data will always be recoverable
- Bit Plane Image preservation format ensures image and sound file recovery for centuries
- A visual representation means all hardware will be backwardly compatible to the first generation
- New, efficient design eliminates “serpentine” recording techniques, ensuring record & read speeds in excess of 1 GByte/sec upon commercial availability
- Each unit of **DOTS** media will have factory-written, human-readable instructions for building a reader on the first few meters – Rosetta Leader

US Government Proof of Concept

- Group 47 successfully completed a contract awarded by the CIA to build a laboratory prototype proving the **DOTS** technology.
- Contract milestones included demonstration of writing and reading applications and document data in the **DOTS** visual format, and successfully writing and reading to **DOTS** metal alloy tape in the Bit Plane Image preservation format.







Performance Specifications

Data Transfer Speed

First Commercial Ship >1 GByte/sec

Media Characteristics

Gen 1 Capacity: 20TB Native	**Tracks per pass:** 15,000
Tape Speed: 20cm/sec	**Passes to write entire tape:** 1
File System Support: LTFS	**Head to Tape Contact:** None
Reel Dimensions: 12” Dia, ¾” Wide	**Media Life:** No less than 200 Years
NVM Capacity: Capacity TBD	**Corrected bit error rate (CBER) of 10^{-18}**
WORM capable: Yes	**EMP/Magnetic Field Sensitivity:** None
Tape Thickness: TBD	**Long Term Storage Temperature:** 16-150°F (-9 – 66° C)
Data, Text and Images: Yes	**Long Term Storage Humidity:** 5%-85%

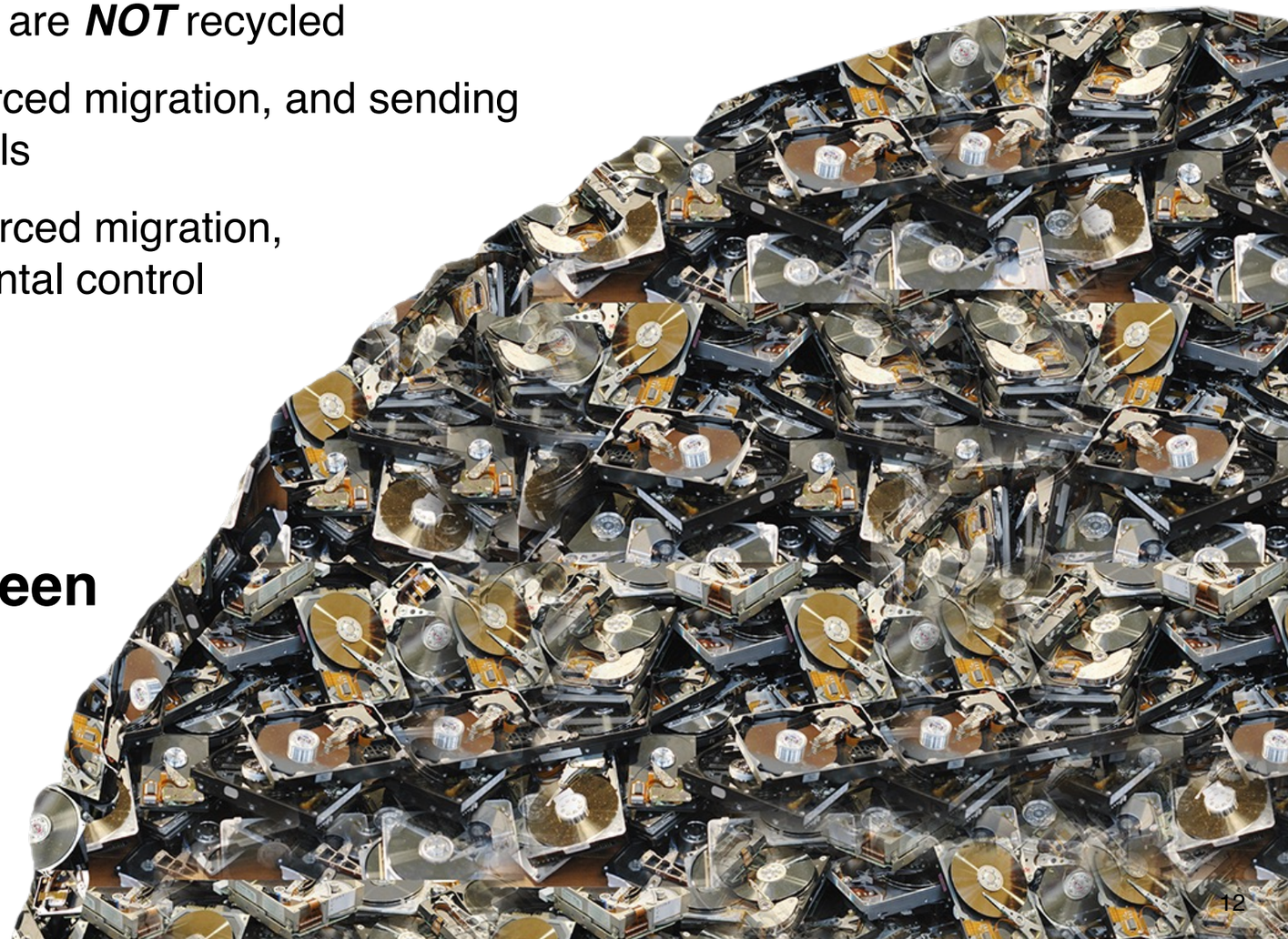
All generations of DOTS media will be backwardly compatible

*all specification are subject to change without notice or obligation and are presented as best estimate at the time of this document.

Current Data Preservation Practices are *Not* Sustainable and Not Good For the Planet

- Whether it's Cloud, enterprise data center, hard drive, data tape, or solid state
- All current storage media end up in landfills and are ***NOT*** recycled
- Current practices create massive waste from forced migration, and sending countless hard drives and data tapes into landfills
- **DOTS** eliminates media & energy waste from forced migration, costly power requirements, and rigid environmental control demands

DOTS is Sustainable & Green



To be clear….

DOTS can store ANY digital file – including images and sound

DOTS can store the same things you would save to your hard drive

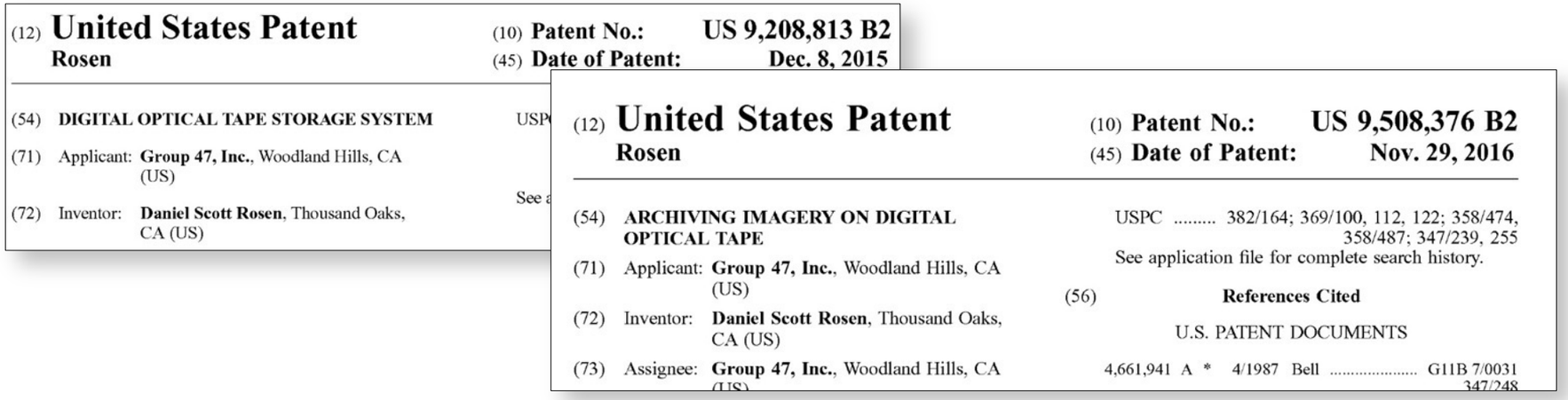
DOTS can store any application like Photoshop, Microsoft Word, Excel, or any of the documents these programs create

Competing Archival Options

Name	Strengths	Weaknesses	Stakeholders
DOTS	▪ Archival for over 200 years, 1 GB R/W speeds ▪ Non-magnetic, WORM, immune from EMP, UV, radiation, water, petrochemicals ▪ Data is non-complex, visual & read with a camera ▪ No environmental constraints ▪ Bit Plane Image format is future proof ▪ Proven in CIA Contract and 20 TB per reel	▪ It isn't a product yet ▪ As with all digital storage, DOTS can be damaged by fire, acid, or a hammer	▪ Group 47
LTO Magnetic Tape	▪ Open standard ▪ Readily Available	▪ Requires stringent environmental conditions ▪ Data loss due to age, magnetic fields, EMP ▪ Migration required every 3-5 years	FujiFilm, HPE, IBM, Quantum
Piql (data on 35mm film emulsion)	▪ 100 Year+ Archival ▪ Difficult to erase ▪ Visual method to store data	▪ Requires stringent environmental conditions to store ▪ Requires film & film processing ▪ Over 200,000 feet of 35mm film to store 8TB (equal to a two Hour 4K Movie)	EU, Norwegian Gov't
DNA	▪ Extremely high density ▪ 500 Year Minimum Lifetime	▪ Current read/write times impractical ▪ Very complex to recover data, vulnerable to radiation, mutations, and air travel above 20,000 feet ▪ 15+ years before commercial, prohibitive cost per TByte	~~Harvard~~, ~~Twist~~, Catalog, ~~Microsoft~~*
5D/Project Silica Data in Glass	▪ Robust Glass Media ▪ Wide temperature storage ▪ Non-Magnetic, WORM storage	▪ Requires powerful Femto lasers to read/write ▪ Microsoft intends to keep proprietary ▪ Slow Read/Write Speeds (2019 10 days to write 75 GB) ▪ It is glass	University of Southampton, Microsoft, (Hitachi had a similar tech, but abandoned as impractical)
Folio	▪ Immune from magnetic fields & EMP ▪ Uses existing DVD White Book Standard	▪ It isn't a product yet ▪ Uses frequency modulation for data storage ▪ Layers subject to delamination, dyes sensitive to UV ▪ Complex mechanism to recover data	Folio Photonics
"The Cloud"	▪ Dispersion of assets ▪ No onsite storage constraints ▪ Access from any internet connection	▪ No knowledge of where assets are ▪ At the mercy of bandwidth ▪ Actual location subject to local jurisdiction ▪ Same limitations as Hard Drives, vulnerable to EMP ▪ Very Expensive for archival	Amazon, Microsoft, Google, HPE, IBM, and others

*It was announced at a Library of Congress meeting on March 2023 that Microsoft & Twist have ceased funding DNA research

Five NEW Patents Awarded to Group 47



(12) **United States Patent**
Rosen

(10) **Patent No.: US 9,208,813 B2**
(45) **Date of Patent: Dec. 8, 2015**

(54) **DIGITAL OPTICAL TAPE STORAGE SYSTEM**

(71) Applicant: **Group 47, Inc.**, Woodland Hills, CA (US)

(72) Inventor: **Daniel Scott Rosen**, Thousand Oaks, CA (US)

USP

See a

(12) **United States Patent**
Rosen

(10) **Patent No.: US 9,508,376 B2**
(45) **Date of Patent: Nov. 29, 2016**

(54) **ARCHIVING IMAGERY ON DIGITAL OPTICAL TAPE**

(71) Applicant: **Group 47, Inc.**, Woodland Hills, CA (US)

(72) Inventor: **Daniel Scott Rosen**, Thousand Oaks, CA (US)

(73) Assignee: **Group 47, Inc.**, Woodland Hills, CA (US)

USPC 382/164; 369/100, 112, 122; 358/474, 358/487; 347/239, 255
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,661,941 A * 4/1987 Bell G11B 7/0031 347/248

- First new patent granted by U.S. Patent Office with multiple claims covering Group 47's unique visual approach for writing and reading digital data
- The second new patent granted covers Group 47's Bit Plane Image method for archiving images (whether images of photos, videos, or documents) that removes all file format dependencies
- The new method for archiving images and sound has quickly become one of the most compelling aspects of **DOTS** for all potential customers, since, with it, **DOTS** can guarantee image and sound files can be read securely decades into the future, without concern for operating system compatibility
- Three more patents have been granted, and twelve additional patents are ready to be filed

Long-Term Digital Archive Options

CLOUD* / MAGNETIC MEDIA VS. DOTS

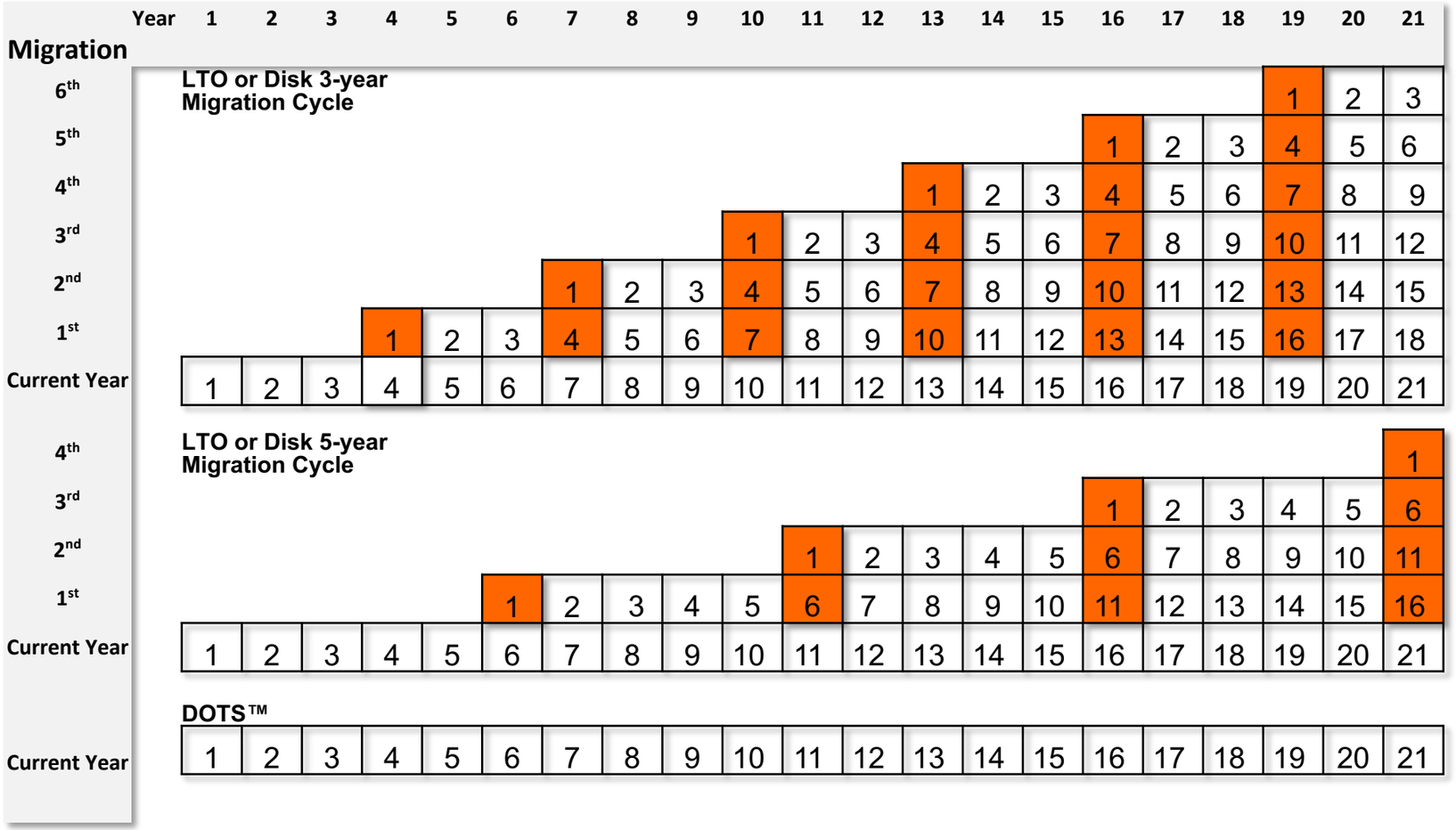
Archiving in the Cloud or Magnetic Media	Archiving with DOTS
• Upload or record to magnetic media	• Record to DOTS media
• Your data is stored in a climate-controlled facility	• Store on a shelf at ANY temperature from 15° to 150° F
• Monitor integrity of Cloud or local storage, if tape, check regularly for degradation & re-pack	• DONE - No re-record required
• Migrate the data before magnetic data loss	
• Risk of data loss / corruption due to media degradation, migration, hardware obsolescence, EMP, solar flares, etc.	
• REPEAT EVERY 3 – 5 YEARS	

*Cloud storage is magnetic media in a data center somewhere

Exponential Growth of Migration Compounds the Problem

Discussions tend to focus on one migration of data created in a given year, yet ignore the subsequent years of data created that will also require migration. Soon, you're faced with migrating multiple years of data in one year.

In a three-year migration cycle, you have the first year of data to migrate after three years. After 6 years it will be time for the second migration of year 1 *and* the first migration for year 4, and so on.



10 Petabytes of LTO-7 takes over a year to migrate with one drive. Within a few years, it will take several years to migrate a single year's migration requirement.

This illustration assumes NO increase in new current-year data, which is unlikely.

Even with no increase in current data, there will quickly be insufficient time in the year to complete the migration of existing and new archive data.

The expected exponential increase in new archival data will further compound the challenge of migration.

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